PB-234 605

THE ATLANTA HOUSEHOLD REFUSE COMPACTOR DEMONSTRATION PROJECT

Bradbury Associates, Incorporated

Prepared for:

Environmental Protection Agency
Solid Waste Management Office

1974

DISTRIBUTED BY:

NTIS
National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

BIBLIOGRAPHIC DATA SHEET

1. Report No. EPA/530/SW66d

2.

PB 234 605

4. Title and Subtitle
The Atlanta Household Refuse Compactor Demonstration Project

5. Report Date
1974

6.

7. Author(s)
Bradbury Associates, Inc. (Charles C. Carrington)

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
Bradbury Associates, Inc.
Architects - Planners
60 Fifth Street
Atlanta, Georgia

10. Project/Task/Work Unit No.

11. Contract/[✓ Grant No.]
G06-EC-00302

12. Sponsoring Organization Name and Address
U.S. Environmental Protection Agency
Office of Solid Waste Management Programs
Washington, D.C. 20460

13. Type of Report & Period Covered
Final

14.

15. Supplementary Notes

16. Abstracts

The study was made to determine whether through the use of home compactors, the City of Atlanta could change their residential collection system from a twice per week, back-door service to once per week, curb-side service. The report summarizes the cost and efficiencies of the various systems evaluated. It also shows that through the use of home compactors, the change to less frequent service could be more easily made and that considerable savings could be realized by the city.

17. Key Words and Document Analysis. 17a. Descriptors

Compacting
Refuse
Wastes

17b. Identifiers/Open-Ended Terms

Solid waste management

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

17c. COSATI Field/Group

18. Availability Statement

19. Security Class (This Report)
UNCLASSIFIED

20. Security Class (This Page)
UNCLASSIFIED

21. No. of Pages
162

22. Price
11.25-1.45

USCOMM-DC

226061

THE ATLANTA HOUSEHOLD REFUSE COMPACTOR DEMONSTRATION PROJECT

This final report (SW-66d) on work performed under
Federal solid waste management demonstration grant no. G06-EC-00302
to the City of Atlanta, Georgia, was written by
BRADBURY ASSOCIATES, INC., Architects-Planners
and is reproduced as received from the grantee

U.S. ENVIRONMENTAL PROTECTION AGENCY
1974

This report has been reviewed by the U.S. Environmental Protection Agency and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of commercial products constitute endorsement or recommendation for use by the U.S. Government.

An environmental protection publication (SW-66d) in the solid waste management series.

PREFACE

Since the introduction of the household compactor to the public and its subsequent purchase and use by homeowners, questions have been raised concerning the effect of the compactor on the solid waste collection system. Does the compactor actually reduce the volume of waste accumulated by the homeowner and by what percent is volume reduced? Is the compactor a convenience or hinderance to the homeowner? If the compactor is indeed a benefit and if it actually reduces volume considerably, it might also be possible to reduce cost of collection.

The prime purpose of this study was to determine if, with compactors in the home, it would be possible to collect once a week instead of the routine twice a week and to determine what savings, if any, might accrue. Resident reaction to the compactor was extremely important because most efficient use of the compactor would not be possible unless the resident was satisfied with its performance.

ACKNOWLEDGMENTS

We wish to express appreciation and gratitude to the City of Atlanta and in particular to the Project Director, Mr. John Evans, who provided valuable technical assistance. Staff members of the Environmental Protection Agency, Mr. Kent Anderson and Mr. Erik Larson, were very helpful and extremely courteous.

Compactors for this project were placed on consignment with the City of Atlanta by the Whirlpool Corporation and Whirlpool also provided the compactor bags and deodorant spray used during the project at a reduced rate. Without the use of the "Trash Mashers", it would not have been possible to evaluate the compactor as a working unit in a solid waste collection system.

Preceding page blank

TABLE OF CONTENTS

Page

PREFACE iii

ACKNOWLEDGMENTS v

TABLE OF CONTENTS vii

I. INTRODUCTION AND PROJECT SCOPE 1

II. CONCLUSIONS AND RECOMMENDATIONS 5

A. Resident Opinion 5
  1. Resident Participation 5
  2. Overall Satisfaction with the Compactor 7
  3. Weight 8
  4. Odor 10
  5. Location 10
  6. Safety 11
  7. Service 11
  8. Miscellaneous 12
  9. Backdoor Collection (Resident Opinion) 12
  10. Curbside Collection (Resident Opinion) 12

B. Disposal Methods 14
  1. Sanitary Landfill 14
  2. Incineration 15

C. Advantages and Disadvantages of Varying Types of Collection Techniques 18
  1. Comparison of Collection of Non-Compacted Refuse to Collection of Compacted Refuse 18
  2. Comparison of Backdoor Collection Methods to Curbside Collection of Non-Compacted Refuse 24
  3. Comparison of Backdoor and Curbside Collection of Compacted Refuse One Time a Week 26
  4. Comparative Costs 26
  5. Comparison of Segments During Curbside Collection of Compacted and Non-Compacted Refuse 28
  6. Comparison of Curbside Collection of the Open Bed Truck to the Compactor Truck During Curbside and Backdoor Collection of Compacted Refuse 28

D. Advantages and Disadvantages of the Compactor As a Part of a System Approach to Metro Trash Collection 31

E. Recommendations 36

Preceding page blank

TABLE OF CONTENTS - CONTINUED

III. Stage 1 39

  A. The Test Route and the Contract 39
    1. Selection of the Test Route 39
    2. Project Promotion 39
    3. Compactor Description 40
    4. The Contract 42

  B. Investigate and Evaluate the Existing Collection System 42
    1. East Liddell Route - Base Data 44
    2. West Maddox Route - Base Data 48
    3. Entire Route - Base Data 51

  C. Curbside Collection 51
    1. Segmented Data 53

  D. Questionnaire I. 56
    1. Total Response 56
    2. Response Based on Household Size 57

IV. Stage 2 62

  A. Phase I. 62
    1. East Liddell Route - Demo Data 62
    2. Landfill Disposal of Compacted Refuse 66
    3. Questionnaire II. 74

  B. Phase II. 79
    1. Entire Route - Demo Data 79
    2. Questionnaire III. 84

  C. Phase III. 91
    1. West Maddox Route - Demo Data 91
    2. Incineration Disposal of Compacted Waste 94
    3. Questionnaire IV. 102

  D. Phase IV. 104
    1. Curbside Collection 104
    2. Questionnaire V. 108

GLOSSARY 117

BIBLIOGRAPHY 119

APPENDICES 121

LIST OF TABLES

Page

I. Resident Rating of Compactor Throughout the Project 9
II. East Liddell Weekly Averages 19
III. Curbside Weekly Averages 20
IV. West Maddox Weekly Averages 21
V. Comparison of Backdoor to Curbside Collection of Non-Compacted Refuse 25
VI. Comparison of Backdoor to Curbside Collection of Compacted Refuse 27
VII. Comparison of Compacted and Non-Compacted Refuse by Segments 29
VIII. Comparison of Open Bed Truck to Compactor Truck 30
IX. East Liddell Route - Backdoor - Base Data 46
X. West Maddox Route - Backdoor - Base Data 50
XI. Entire Route - Curbside - Base Data 52
XII. Segmented Data - Entire Route Curbside 1-28 54-55
XIII. Questionnaire I 58-61
XIV. East Liddell - Backdoor - Demo Data 64-65
XV. Landfill Test Data 71
XVI. Questionnaire II 75-78
XVII. Entire Route - Curbside - Demo Data 80-81
XVIII. Segmented Data - Curbside - Demo Data 82-83
XIX. West Maddox Route - Backdoor - Demo Data 92-93
XX. Entire Route - Open Bed Truck 105

LIST OF PHOTOGRAPHS

I. Compactor 43
II. Compactor Truck 47
III. Satellite Vehicle 47
IV. Landfill Cell 1 - 100% Compacted Refuse 70
V. Compacted Refuse in Cell 70

Page

VI. Refuse Pit at Incinerator 95
VII. Refuse Storage Pit 95
VIII. Charging Refuse in Incinerator 95
IX. Curbside Collection Open Bed Truck 107
X. Putting Canvas in Place - Open Bed Truck 107
XI. Dogs Scattering Refuse 113
XII. Dogs at Work on Curbside Collection 113
XIII. After Dogs are Finished 114
XIV. Typical Home on Project Route 114
XV. Compactor Bag 115
XVI. Atlanta Officials Look Over Compactor 115

LIST OF FIGURES

Page

1. Map of Project Collection Route, Northwest Atlanta 41
2. East Liddell Route 45
3. West Maddox Route 49
4. Incinerator and Landfill in Relation to Project Route 67
5. Surveyor's Plan for Landfill Cells 68
6. Shape of Test Cells 69
7. Hartsfield Incinerator 96
8. Schematic of Hartsfield Incinerator 97

APPENDICES

A. News Release 121
B. Letter to Residents 122
C. Data Forms and Definitions 123-126
D. Cost Tables 127-128
E. Data Forms and Definitions 129-132
F. Data Forms and Definitions 133-135
G. Identification of Segments 136
H. Questionnaire I. 137
I. Landfill Data Forms 138
J. Questionnaire II 139-140
K. Questionnaire III 141-144
L. Incineration Test Data Form 145
M. Incineration Operating Rates 146-149
N. Incineration Registered Temperatures 150-155

I. INTRODUCTION AND PROJECT SCOPE

One of the most important problems facing our cities today is that of solid waste management. Each day Americans enrich their environment with 500,000 tons of solid waste. The United States spends $4.5 billion a year disposing of 350 million tons of refuse and Federal officials expect the tonnage to double in 20 years at a rise in cost of four percent per year. It is estimated that each American averages five pounds of solid waste each day as compared to 2.75 pounds in 1920. Today there are 205 million Americans as compared to 105 million in 1920.

In terms more realistic, less abstract, think of 30 billion empty bottles each year, 60 billion cans, 20 million tons of paper, four million tons of plastic, seven million junked cars, 100 million old tires and more than a million burned out television sets. These statistics do not include litter on the countryside, nor the more than three billion tons of solid waste dumped directly by farms, mines and industries and never reach public collection and disposal systems.[1]

The growing mass of refuse of all kinds seems due primarily to four factors: (1) accelerated population growth, (2) urbanization, (3) growing affluence and (4) planned obsolescence. Accelerated population growth would not alone create a problem if it were not for urbanization. At present 90 percent of the people live in towns with populations over 2500. These people can afford the cost of disposables. Paper products for every need are abundant and the average American can purchase a new car every three years. The consumer is urged to buy the new and trade in or throw away the old. The rise of the non-returnable container, inspite of the fact it costs the user more than the old type is another illustration of the close relationship between market strategy and generation of solid waste.[2]

Higher rates of solid waste production raise another problem of where to put the refuse. Urban sprawl is erasing space between cities and increased distances to landfills add considerably to total cost. An incineration process is expensive to build and operate and the residue must be disposed, however, its greatest handicap is the air and water pollution which are common by-products.

The solid waste management problem and especially the problem of ever mounting cost of collection is of special concern to the City of Atlanta. As much as one of every ten municipal tax dollars is earmarked for collection and disposal of residential refuse. Principally the funds are expended in the collection operation with approximately 20 percent of the funds used for disposal systems. Currently the Atlanta Sanitation Department serves an area with population totaling 535,798. This figure is projected to increase to 605,710 persons by 1980. The average amount of solid waste actually collected in the city exceeds 5.3 pounds per person per day. Considering the likely possibility that the amount of waste material to be collected will increase per capita to eight pounds per day by 1980, the Sanitation Department will be collecting and disposing over 2,422 tons per day by 1980. Refuse volume is increasing greatly each year and products are manufactured of materials not easily degraded if at all with minimal efforts being made toward recycling. Labor problems complicate the situation as the job is hard, dirty and salary often lowest on the municipal wage scale. Adequate work forces are difficult to keep as opportunities for advancement cut into the labor supply.

---

[1] Better Homes and Gardens, Garbage Pollution: What Can You Do To Help, October 1971, p. 14.

[2] McLean, Mary, Planning for Solid Waste Management, Planning Advisory Service, Report No. 275, December 1971, pp. 13-14.

Presently the Atlanta Sanitation System functions with an annual operating budget of $16.00 per capita exclusive of capital improvements and construction supporting the system. Improved equipment and management techniques have kept the program operational and the people of Atlanta have, as a result, enjoyed better than average sanitary collection and disposal services. Residents are accustomed to backdoor collection twice each week. The demand for manpower and equipment continues to mount and since collection expenditures amount to approximately 80 percent of the budgeted municipal sanitary service expenditures, Atlanta is looking for sound ways to further improve the system and reduce collection cost.

The Atlanta Household Refuse Compactor Demonstration Project was designed as an attempt to reach a solution to major problems of cost and volume. Collection costs might be substantially decreased by reducing refuse volume at the source, the home, utilizing the household refuse compactor. The compactor was designed to reduce 25-30 pounds of garbage, a week's supply for most families, into a small, treated bag. If the compactor is properly located, the resident would handle garbage less frequently, perhaps once a week and the usual garbage load of six or seven bags could be reduced by compression approximately to the size of a grocery bag.

The demonstration project was designed to determine if the compactor used as a part of the solid waste collection system would reduce volume sufficiently to permit collection once a week. Added anticipated advantages beyond the reduction in collection schedule could include the possible use of less expensive collection equipment or a reduction in the number of men presently required for collection crews. The disposal of compacted refuse might also prove advantageous as opposed to a greater volume of non-compacted refuse. Furthermore, would it be to the city's advantage to encourage purchase of residential compactors? What specifically are the advantages and how far can a city go in encouraging purchase of this type of equipment? On the basis of these suppositions and questions, the Atlanta Household Refuse Compactor Demonstration Project was developed. Study procedures for the project were:

1. Select an appropriate test route and initiate a complete investigation and evaluation of the existing collection system including personnel and equipment presently in use.
2. Place a household refuse compactor in each residence throughout the test route for the duration of the test period.
3. Engage in four, three month, test periods designed to evaluate variation in collection procedures, schedules, equipment and crew sizes as well as customer acceptance, maintenance requirements and actual operation of the refuse compactors.

During the project the data collection and analysis dealt with two types of information; information relating to collection and disposal of compacted waste and information relating to the compactor and its operation. Collection operation variables considered were: crew sizes, scheduling, curbside and backdoor pickup, equipment and the disposal characteristics of compacted waste. Hardware operation variables considered were: customer acceptance and actual performance of the compactor.

The development of the Atlanta Household Refuse Compactor Demonstration Project proceeded in two stages over a two year period. The first stage, covering six months, consisted of selecting an appropriate test route. The test route chosen was an upper middle income suburban neighborhood with primarily uniform single family dwellings of average family size. This criteria presumably represents the typical market for the household compactor as it was assumed this group of residents would be more willing to cooperate carrying out program details. The route size of approximately 400 residents provided the desirable number of residents that could consistently and realistically be handled by one crew and one six ton capacity compactor truck in a single day. In addition, the route size provided an adequate and realistic sample on which project findings could be based.

A complete investigation and evaluation of solid waste management techniques currently provided on the selected demonstration route were documented for use in program evaluation and as a basis for measuring change. The study of existing conditions concerned with basic time and motion data included personnel, materials and equipment. This data covered 16 collections over an eight week period. Four weeks of the evaluation were concerned with backdoor collection and four weeks were directed to the characteristics of curbside collection.

The second stage covered a full year and is divided into four three month test phases designed to evaluate variations in crew sizes, pickup schedules, curbside and backdoor pickup, different type collection trucks, customer acceptance, and finally, the actual characteristics and performance of the refuse compactor and the standard incineration and landfill capabilities of the compacted waste. Each phase was followed with a questionnaire evaluating compactor use and collection.

The first three month study phase specified backdoor pickup of the compacted refuse. Regular collection equipment was used and the work crew consisted of a driver and two satellite vehicle drivers. Pickups were scheduled once a week and all compacted refuse was delivered to the sanitary landfill where test cells were reserved to test landfill capabilities of compacted waste. Landfills were prepared and operated according to standard accepted sanitary landfill procedures. A questionnaire was prepared and mailed to residents at the end of this study phase.

The second study phase duplicates the testing procedure outlined in study phase one except all compacted refuse was placed at curbside. This test utilized a compactor truck, driver and two man crew accompanied by the Project Director. Landfill tests continued throughout this phase. At the close of the second study phase a prepared questionnaire combined specific questions concerning characteristics of the refuse compactor as well as resident reaction and experience with curbside pickup.

The third study phase, while concerned with the basic testing procedures earlier outlined in Stage 1, reverted to backdoor pickup with regular walking crew. All compacted waste was transported to the incinerator. Incineration tests included an experiment to determine the variable in the charge rate required to burn varying percentages of compacted waste and normal burn. The percentage of burnout with varying amounts of compacted waste was measured to normal burnout. The same basic crew arrangement continued to the end of this phase. The next questionnaire was given to the resident.

The fourth study phase combined the convenience of curbside collection with the open bed truck. The time and motion data was recorded by the Project Director and the system operated with an open bed truck for six weeks. The final survey and questionnaire was completed at the close of the fourth study phase. This questionnaire contained questions related to the total program and use of the equipment for one year.

In order to examine the report in depth, it is recommended the reader proceed to Part III, Stage I on page 39 by-passing the Conclusions and Recommendations which are placed at the beginning of the report for reference ease.

II. CONCLUSIONS AND RECOMMENDATIONS

Conclusions were derived from several sources. 1. The resident has a great deal to say about the compactor and the varying methods of collecting the compacted refuse. 2. The landfill method of disposal as opposed to the incineration process is of particular importance as it relates to the disposal of compacted refuse. 3. Varying modes of collection with cost analysis of each mode is very revealing. 4. A model city demonstrates the economic feasibility of utilizing the compactor within the solid waste system.

The Recommendations were designed to alleviate the financial burden of collecting solid waste in the City of Atlanta and at the same time mollify the pain of recommended changes in collection.

A. Resident Opinion

In order to evaluate the compactor as a viable component within a systems analysis approach to solid waste handling, it is important to thoroughly examine and measure resident reaction to the compactor. It will be necessary to weigh those obvious advantages and disadvantages of the unit as described by the participants in the study who have used the compactor for a twelve month period.

1. Resident Participation

In order to obtain permission from the residents on the test route before compactors could be placed in their homes, a contractual agreement between the City of Atlanta and the resident had to be signed. Within the text of the contract, the City of Atlanta agreed to remove the compactors if at any time the resident no longer wished to participate in the project. During the course of the project, four percent of the residents did request removal of the compactor. Outstanding reasons for this request were: (a) The compactor was not utilized to full capability, if at all and (b) the resident felt participation in the curbside phase of the study just too much trouble. Normally trash is collected at the backdoor twice each week but once the compactor was placed in the home, collection began once a week with pickup at the backdoor for three months, curbside three months, backdoor three months and curbside three months. The resident, in order to participate in the study had to agree to the prescribed collection methods.

More importantly, some residents on the proposed route did not wish to sign the contract and allow the city to place the compactors in their homes even though the compactors were free to use for one year. Because of the lack of interest, one street on the proposed route was dropped and new streets were added to the route. At the end of the study stamped self-addressed post cards were sent to the 101 residents who lived on the street that was eliminated from the project route.

The following question was asked:

> The Atlanta Household Refuse Compactor Demonstration Project is now almost complete. In order to clearly evaluate the compactor as part of a refuse collection system, a reply to the following question would be very helpful. Why were you not interested in using a compactor and participating in the study?

Forty of the 101 cards sent were returned. Results of this survey are as follows:

19%	No place to put the compactor
6%	Required to participate in curbside collection
3%	Family is away from home a good deal of the time
3%	Moved to neighborhood after project was begun
2%	Very small family generating little refuse
2%	Do not like garbage in the house for a week
1%	Expected to move away from Atlanta
1%	Failed to return the contract to the city
1%	Poor information on the compactor and the project
1%	Seemed dangerous with small children around
1%	Full bag too heavy to lift and when deodorizer is out of order, the odor is impossible
61%	No response

It is not known just how many residents on the street were actually contacted, but it can be assumed at least 40 did not wish to participate in the project and at least half of the 40 did not have a place to put the compactor. The problem of finding a location for the compactors in the home was the major reason for resident refusal to participate in the project. The second factor involved was curbside collection. A few, six percent of 40, did not wish to participate in curbside collection.

The City of Atlanta was supplied with 400 compactors and an average of 380 compactors were placed. It was not possible to place the remaining compactors on the test route because of resident refusal to comply. Therefore, those homes on the test route not participating in the project were supplied normal collection at the backdoor twice each week. Meanwhile, homes participating in the project were supplied collection service one time a week at the curbside and backdoor alternating every three months. The dual collection system necessary during the test was a nuisance, cumbersome, expensive and a handicap to the collection crew as well as confusing to the residents on the test route.

The greatest problem to be dealt with when considering the compactor as a part of a solid waste collection system is convincing the resident to participate. In view of the small number of people involved, five percent (one percent who refused to participate and four percent who requested compactors be removed from their homes after the project was underway), the problem is not considered significant. The street that was dropped from the route was not considered within the five percent because of very poor presentations by survey members assigned this street. These members were replaced and no more problems occurred.

In summary, the chief problems in placing household refuse compactors in Atlanta are finding a location for the compactor and resident unwillingness to cooperate with curbside collection; however, only five percent of the residents were affected and no doubt these problems would disappear if collection was in fact once a week curbside.

2. Overall Satisfaction with the Compactor

In every questionnaire the residents were asked to give an opinion on general satisfaction with the compactor. In each questionnaire response was very favorable. Approximately 80 percent of the participants rate the compactor as excellent or good. See the summary on Table I.

Almost half the residents felt reduction in volume of wastes generated to be the most desirable advantage of the compactor. Reduction in volume created positive side effects such as: (a) elimination of garbage bags, (b) fewer cans required to contain refuse and (c) an overall neater, more orderly appearance. Another and certainly very important advantage of the compactor for at least a third of the residents was the fact that they did not have to make a trip to the garbage can every day. Many residents considered the compactor a convenient worksaver and especially enjoyed storage of trash in one small unit.

The compactor does have some disadvantages according to the residents. It must be noted that disadvantages are mentioned by a low percentile group and are not considered serious. The major disadvantage of the compactor is the weight of the bag. Approximately 30 percent of the residents felt the compactor was hard to unload, the bag was heavy, difficult to carry or hard to handle. The second disadvantage of the compactor was odor emitting from the unit. And finally, residents complained of difficulty finding a location for the compactor in their homes, even though most agreed as to where the compactor should be located. Disadvantages of the compactor will be explained more fully on following pages.

Just how well did the resident on the test route use the compactor? Approximately 85 percent of the residents placed three-fourths of their refuse in the compactor throughout the study. Most of the residents put refuse in the compactor loosely and the majority changed the bag every 3-7 days indicating either collection day was at hand or the bag was full. Eighty five percent of the responses revealed residents felt they must change the bag every seven days. There was no evidence anyone wanted to keep the bag in the compactor longer than six days or past the weekly collection day. Since the bags were provided to the resident free of charge, no doubt use was liberal. Once the resident begins to pay for the bags and collection resumes twice a week, it is expected the bags will be used for a longer period of time. Eighty five percent of the households experienced a reduction in volume of at least half and some households experienced an even greater reduction in volume.

3. Weight

Nearly a third of the residents complained of the weight of the compactor bags. Most of the residents felt the bag too heavy for the woman of the house to remove from the compactor. Consequently, the man usually took the bag out of the compactor and to the receptacle. Protesting residents agreed the bag was difficult to carry and hard to handle. The Project Director, in order to determine how heavy the bags actually were, weighed bags during collection. Compactor bags were picked at random and weighed on simple bathroom scales (accurate ∓ one pound). This sample was taken during the satellite vehicle demonstration phase and did not interfere with normal collection procedures.

(1)	35	(21)	26	(41)	23	(62)	20	(83)	23
(2)	15	(22)	21	(42)	21	(63)	18	(84)	27
(3)	15	(23)	21	(43)	20	(64)	28	(85)	14
(4)	23	(24)	19	(44)	16	(65)	12	(86)	14
(5)	23	(25)	31	(45)	22	(66)	10	(87)	11
(6)	31	(26)	18	(46)	30	(67)	23	(88)	21
(7)	8	(27)	19	(47)	22	(68)	12	(89)	23
(8)	16	(28)	19	(48)	16	(69)	27	(90)	19
(9)	38	(29)	17	(49)	32	(70)	19	(91)	21
(10)	31	(30)	19	(50)	20	(71)	22	(92)	20
(11)	11	(31)	17	(51)	22	(72)	13	(93)	20
(12)	20	(32)	15	(52)	33	(73)	11	(94)	19
(13)	17	(33)	22	(53)	15	(74)	19	(95)	24
(14)	13	(34)	12	(54)	29	(75)	12	(96)	26
(15)	12	(35)	13	(55)	23	(76)	23	(97)	19
(16)	17	(36)	19	(56)	17	(77)	23		
(17)	25	(37)	29	(57)	24	(78)	26		
(18)	18	(38)	18	(58)	20	(79)	22		
(19)	14	(39)	12	(59)	19	(80)	20		
(20)	31	(40)	23	(60)	31	(81)	11		
				(61)	23	(82)	28		

1981

$$\frac{1981}{97} = 20.4$$

pounds average bag weight

Average weight of the bags sampled was certainly a reasonable load to handle, however, 14 of the bags weighed between 28-38 pounds. The manufacturer states a bag of compacted waste should weigh between 20 and 30 pounds. It is very possible some residents may be filling the bags extremely full or an unusual number of cans or glass could increase the weight load. At any rate, practice should increase the ability of the resident to know just how much refuse constitutes a bag that is full enough to achieve efficient use of the compactor and at the same time will not be too full as to be heavy or difficult to handle.

TABLE I

RESIDENT RATING OF COMPACTOR THROUGHOUT THE PROJECT

Compactor rating	Q II 372 responses	Q III 308 responses	Q IV 285 responses	Q V 356 responses total performance for the year
Excellent	60%		43%	45%
Good	27%		41%	46%
Fair	10%		12%	7%
Poor	3%		4%	2%
Completely satisfied		39%		
Satisfied		47%		
Some dissatisfaction		9%		
Completely dissatisfied				
Luxury			18%	
Convenience			66%	
Necessity			8%	
No response		1%	8%	
Not using the unit		4%		

4. Odor

As the project advanced, more than half the residents encountered some problem with odor emitting from the compactor. According to the majority of residents compactor odor problems occurred only once or twice during the year. Odor is caused by food waste placed in the compactor. Chicken, fish and fruit are prime offenders. Meat wrappings were also considered to be contributors. Residents who have garbage disposals do not have compactor odor problems whereas those residents who do not have a garbage disposal and place food items in the compactor do experience odor in the unit. The compactor is most ideally used in conjunction with a garbage disposer, it was not designed to replace the food waste disposer.

The compactor is equipped with a deodorant spray designed to eliminate odor caused by food placed in the compactor. Since odors occurred only once or twice during the course of the year, the deodorant spray is doing a fairly good job. Those residents who complained most vigorously of odor were given an opportunity to test a new spray being developed by the manufacturer. All residents, but one, rated the new spray satisfactory.

One of the most surprising answers in Questionnaire III relating to the deodorant spray was to the question, "How often do you change the deodorant spray?" The residents had been using the compactor approximately nine months and 15 percent stated they had not changed the spray. According to the manufacturer, the spray should last four to five months. Either the residents had a garbage disposer in the home or they experienced some problem with odor because the spray had not been changed.

In summary, odor problems occurred only once or twice during the year to approximately half the residents. It was not a serious problem and can be resolved. For those who do not have a food waste disposer, food items such as meat, chicken and fruit are the prime odor makers and should not be placed in the compactor. The new deodorant spray tested on the route by those having odor problems was judged satisfactory. Release of a better spray should eliminate many odor problems. The compactor was not designed to replace the food waste disposer and if used in conjunction with a disposer results are very satisfactory.

5. Location

Location is an important consideration concerning the compactor. As stated before, some residents would not and could not participate in the project because there was no place for the compactor. The Project Director visited several homes of those who would have liked to participate in the project to see if a spot was available that had been overlooked. Often no convenient space was available. Older homes on the route have limited kitchen space. Newer homes have completely built-in kitchens. The manufacturer recommends the kitchen as the best location for the compactor and approximately 62 percent of the residents did place the compactor in the kitchen. Another 26 percent of the residents placed the compactor in a room immediately adjacent to the kitchen or in the utility room. During the course of the study, nine percent of the residents moved the compactor from its original location. Six percent of these residents moved the unit from another room to the kitchen or moved the compactor already located in the kitchen closer to the stove, sink or other more convenient location within the confines of the kitchen.

The majority of the residents agreed the best location for the compactor to be under the counter and near the sink in the kitchen.

6. Safety

As with any sort of equipment involved in solid waste handling, safety is a valid consideration and most especially with equipment designed to crush refuse. As far as the compactor is concerned, operation is quite safe. Once the ram begins its downward thrust, the drawer cannot be opened until the unit stops operating or the stop button is pushed, at which time, the ram returns to the stop position before allowing the drawer to open. One family on the route kept the compactor in the basement because they felt the unit was not safe around small children. This was an unusual circumstance. Actually, the drawer must be lifted slightly before opening, an operation that is very difficult for a small child due to lack of sufficient strength and height for the operation. The unit is equipped with a lock that will keep the ram from moving.

Care should be taken when handling compactor bags. The residents were asked how often sharp objects penetrated the bag. Response was:

Every week	11%
Every other week	4%
Sometimes	38%
Rarely	31%
Never	14%
No response	2%

They were then asked if they considered this a safety hazard.

Yes 33% No 44% No response 23%

During the study a boy was cut while carrying the compactor bag from the house to the curb. This cut was serious enough to require stitches. Many who felt the situation creates a safety hazard feared being cut either by glass penetrating the bag or by glass falling to the floor through a hole in the bag. However, 83 percent of the residents said the bags were penetrated sometimes, rarely or never and more than half, 67 percent of the respondents, felt the bags do not constitute a safety hazard. Many participants felt improper handling to be the cause of accidents and with proper care in packing the compactor, bags would not be penetrated.

One crewman was cut during collection of the compacted bags. A bag was thrown to him by another collector on the curb. When this occurred, the Project Director instructed the collectors: (a) Do not throw or toss compactor bags except into the truck. (b) Gloves are to be worn at all times. Since this instruction no more accidents occurred.

7. Service

The compactors did require service during the course of the project. A rash of calls were made shortly after placing the units in the home. These calls were due primarily to manufacturer's defect, homeowner lack of understanding on the operation of the unit and general getting acquainted problems. During the year the compactor was in use primary service problems were:

(a) latches becoming inoperative
(b) unit will not switch off properly
(c) drawer stuck
(d) unit would not run
(e) deodorizer out of order
(f) motor burned out
(g) occasionally a paper item would stick behind the ram and the unit would not work

8. Miscellaneous

The compactor is fitted with a key lock. When the unit is locked, the ram will not move. However, when asked if the resident used the key, almost all stated they did not.

The drawer was easy to operate for most residents on the route. Fifteen percent did find the drawer difficult to operate.

Occasionally pests were found in the compactor. Fruit flies, ants, roaches, maggots and even a mouse were described by the residents as being present in the compactor. This was considered a minor problem as it occurred only once or twice to seven percent of the residents.

9. Backdoor Collection (Resident Opinion)

The participants on the test route agreed to try varying collection techniques as well as collection once a week instead of twice a week. During the first and third quarters of the test year collection crews picked refuse up at the backdoor once a week. Questionnaire III asked the resident if backdoor collection was better overall.

before installation of the compactor	10%
after installation of the compactor	63%
it was the same	15%
no response	12%

Questionnaire V, answered at the end of the study, states that 85 percent of the residents felt the compactor was helpful with backdoor collection and 92 percent felt backdoor collection once a week would be sufficient if there was a compactor in the home. Eighty five percent of the residents placed one or two parcels at the backdoor for collection once a week.

Approximately one third of the residents felt backdoor collection once a week would be sufficient even without a compactor in the home.

10. Curbside Collection (Resident Opinion)

Curbside collection is another matter entirely. Normal collection in the City of Atlanta is effected twice a week at the backdoor and the residents are very opposed to curbside collection. Therefore, any information pertaining to curbside collection with or without the compactor is important and any positive response to curbside collection however small is more important than it might be in other locales. Curbside collection was effected once a week during the second and fourth quarter of the project.

In response to Questionnaire II, 16 percent of 372 residents who replied, complained of curbside collection.

In response to Questionnaire III, "Was curbside collection better overall"

before installation of the compactor	5%
after installation of the compactor	63%
same	12%
no response	20%

Obviously the resident did feel the compactor was a help with curbside collection however, in Questionnaire IV, approximately two-thirds of the residents found it inconvenient or undesirable to take refuse to the curb. Primary complaints concerning curbside collection in order of frequency were:

1. Bags too heavy.
2. Dogs create litter.
3. Too much trouble.
4. It is difficult to remember one pickup day a week and hard to store trash for another week if you forget.
5. Street looks terrible.
6. Poor health.
7. Steep hill.
8. Bad weather
9. House too far from curb.
10. Taxes are sufficient for backdoor collection.

As in Questionnaire III most of the respondents to Questionnaire IV agreed the use of the compactor did reduce the burden of taking trash to the curb. However, it was also discovered that one-third of the residents did not seal the bag before placing it at the curb. An unsealed bag is an open invitation to dogs.

It is most important to note that one-third of the residents actually stated they did not find it inconvenient or undesirable to take refuse to the curb. In an area as opposed to curbside collection as this area, a response such as this is remarkable.

The majority of the residents agreed that once a week curbside collection is adequate for an area with a compactor in the home.

Questionnaire V was more explicit on the matter of curbside collection. The chief problems with curbside collection were:

1. Litter created by dogs. (26%)
2. Trip to the curb in varying weather. (26%)
3. Weight or bulk of refuse. (25%)
4. No problem. (16%)
5. Unsightly streets because of cans. (7%)

Three-fourths of the residents felt the compactor to be a help during curbside collection and one-fourth did not agree. Most agreed it was possible for dogs to tear open a compactor bag even if it was sealed. When asked "if collection were curbside, with a compactor in the home, which would you prefer, collection once a week or collection twice a week?" the majority preferred collection once a week. Most of the residents take one or two items to the curb, the same amount, by the way, they have at the backdoor during collection once a week with a compactor in the home.

When asked if there was a question of higher taxes and collection at the backdoor twice a week or curbside collection or collection one time a week at the backdoor with a compactor in the home, which would you choose?

5%	higher taxes with backdoor collection twice a week
9%	curbside collection twice a week
85%	compactor in the home and backdoor collection one time a week
1%	no response

Residents do not want curbside collection with or without a compactor. However, in view of mounting collection costs backdoor collection is rather prehistoric. If some of the "undesirables" with curbside collection were eliminated, this method of collection would be more palatable. For example, a mobile cart to haul the cans or compactor bags would eliminate the burden of weight and make the trip to the curb in varying weather easier. Dogs prevented from running would eliminate littering and the resultant unsightly streets.

The majority of residents prefer collection one time a week and with a compactor in the home collection once a week curbside could become a reality.

B. Disposal Methods

Two methods were used to test compacted refuse, landfill disposal and the incineration process. Compacted refuse was tested with a base of normal refuse from the same general area as the project route.

1. Sanitary Landfill

During the test period, 199 tons of compacted refuse and 131 tons of normal refuse were placed in the test cells. Observation of the landfilling activities showed no discernible difference in the two test cells. The landfill operator was able to effectively spread and compact the test refuse without difficulty. When questioned about the compacted refuse, the operator said he could see "no difference" in the landfilling characteristics of compacted versus normal refuse. Blowing paper was not a problem in either cell.

Examination of the compacted refuse before compaction by the crawler-tractor showed most of the bags to be intact, although the majority of the bags were not sealed in any fashion. After the refuse was dumped out of the collection truck it was spread over the working face of the cell and compacted by the crawler. Examination of the refuse after this compaction revealed no compactor bags left intact. The grousers on the tractor shredded the bags beyond recognition.

A summary of the landfill test data follows:

	COMPACTED TEST CELL	NON-COMPACTED TEST CELL
Pounds of refuse in place	398,790	262,300
Buckets of cover material (3 cu.yd./bucket)	70	53
Pounds cover per bucket (uncompacted dirt)	6,000	6,000
Pounds cover material	420,000	318,000
Volume of each cell (yd^3)	572.5	563.0
Landfill density * (final)	700 lbs/yd^3	470 lbs/yd^3
True density ** (final)	1430 lbs/yd^3	1030 lbs/yd^3
Landfill density (9-7-71)	590 lbs/yd^3	400 lbs/yd^3
True density (9-7-71)	1270 lbs/yd^3	850 lbs/yd^3

*Landfill density = refuse weight/volume of cell
**True density = refuse and cover weight/volume of cell

Increases in both landfill and true densities can be noted between the survey taken in September 1971 and the final survey. These density increases may be attributed to the compacting effect of additional refuse and cover added, and also to the settling effect over time.

Conclusion: Observations by the Project Director and other City of Atlanta officials agree there are no differences in landfilling compacted waste versus normal waste. Compactor bags will not interfere with normal biological degrading in the landfill since they are completely destroyed by the crawler-tractor.

Landfill density is the most meaningful calculation due to the excess amount of cover necessary in each cell. The above calculations reveal a significant difference in the density which can be achieved by using household compactors. The use of in-home compactors leads to much greater density in the landfill; and, subsequently, more efficient land use. Obviously, the compactor in the test home is able to more thoroughly reduce refuse volume than crawler tractor used at the fill site because landfill density reveals that 50 percent more compacted refuse could be placed in a landfill cell than non-compacted refuse.

2. Incineration

Two incineration tests of compacted refuse were performed. Test 1, conducted January 20, 1972, demonstrated the incineration of 100 percent compacted refuse. Test 2, conducted February 24, 1972, demonstrated incineration of a mix of 77 percent compacted refuse with 23 percent non-compacted refuse. For comparison, base data refuse (non-compacted) was collected from the same area and over the same period of time as the compacted refuse. Presumably, this control assured the same general characteristics and moisture content. All test refuse was weighed at the incinerator scales before being placed in the storage pit. Separate piles of base data material and demo material were maintained in the storage pit.

The following data was collected for each test:

(1) Total charge each test.
(2) Time elapsed each test.
(3) Temperature record ignition grate.
(4) Temperature record rotary kiln.
(5) Speed of ignition grate (given as percent of 100%).
(6) Speed of rotary kiln (given as percent of 100%).
(7) Total residue, each test.

A summary of the first incineration test of non-compacted and compacted material is shown below:

SUMMARY OF INCINERATION TEST 1

Total Refuse Charge	
Non-compacted	86,600 lbs.
Compacted	90,180 lbs.
Total Cycle Time	
Non-compacted	2 hrs. 45 min.
Compacted	3 hrs. 20 min.
Consumption Rate	
Non-compacted --- 525 lb/min...or	15.75 ton/hr.
Compacted --------- 451 lb/min...or	13.53 ton/hr.
(Normal capacity standard for this unit - 10.4 ton/hr.)	
Burning Temperature - Ignition Grate	
Non-compacted	1903° F
Compacted	1966° F
Burning Temperature - Rotary Kiln	
Non-compacted	1643° F
Compacted	1717° F
Refuse Travel Rate - Ignition Grate (% of 100)	
Non-compacted	45.7%
Compacted	38.9%
Refuse Travel Rate - Rotary Kiln (% of 100)	
Non-compacted	55.4%
Compacted	45.6%
Residue	
Non-compacted	23,720 lbs.
Compacted	16,900 lbs.
Weight Reduction	
Non-compacted	27.4%
Compacted	18.7%

The summary of the second test of incineration of compacted refuse is shown on the chart below. Base data refuse was consumed initially; then the demo mix was burned. The demo mix consisted of 77 percent compacted refuse, 23 percent non-compacted refuse.

SUMMARY OF INCINERATION TEST 2

Total Refuse Charge
Base Data - Non-compacted ------------------------------ 87,720 lbs.
Demo Data - Compacted --------- 80,680 lbs.
Non-compacted ---- 23,920 lbs. ------------------------------ 104,600 lbs.

Total Cycle Time
Base Data ------------------------------ 4 hrs. 15 min.
Demo Data ------------------------------ 4 hrs. 35 min.

Consumption Rate
Base Data ---- 344 lb/min...or ------------------------------ 10.3 ton/hr.
Demo Data --- 380 lb/min...or ------------------------------ 11.4 ton/hr.
(Rate capacity this unit ----- 10.4 ton/hr.)

Burning Temperature - Ignition Grate
Base Data ------------------------------ 1800° F
Demo Data ------------------------------ 1780° F

Burning Temperature - Rotary Kiln
Base Data ------------------------------ 1626° F
Demo Data ------------------------------ 1697° F

Refuse Travel Rate - Ignition Grate
Base Data ------------------------------ 32%
Demo Data ------------------------------ 39%

Refuse Travel Rate - Rotary Kiln
Base Data ------------------------------ 42%
Demo Data ------------------------------ 49%

Residue
Base Data ------------------------------ 32,140 lbs.
Demo Data ------------------------------ 34,620 lbs.

Weight Reduction
Base Data ------------------------------ 36.6%
Demo Data ------------------------------ 33.1%

There are several restrictions in the data that should be brought to light before any conclusions are formed from the analytical data. The charge weight may be accurate ∓ 10 percent due to variations of scales during weighing and handling by the crane man to and from storage piles. The cycle time is extremely difficult to measure. A large marker (55 gallon drum) was used to mark the test charge and then observed as it passed over the end of the kiln. It is possible for a marker of this sort to bridge in the hopper and arrive late or it may roll in the kiln and arrive too early. For this reason, cycle time accuracy is estimated at ∓ 15 minutes. The residue weight is affected by both of the above. Variations in scales are in evidence and the accuracy of the test marker determines the accuracy of residue material. With the above considerations in mind, any small differences found in comparison of compacted versus non-compacted refuse will be considered insignificant.

The primary objective of the incineration process was to achieve almost complete consumption of solid waste. The simplest way of monitoring the quality of the operation was to visually inspect the residue for unburned combustible material. The quality of residue in each test was excellent. Occurrence of unburned combustibles in the residue was almost non-existent. Tin cans were salvageable and there were no unburned materials.

The good quality of residue was achieved (in each test) under normal operating conditions. No special attention was directed toward compacted refuse because none was needed. At this point, the overall test objectives were met because no inherent problems were in evidence.

Examination of test data results reveal that in Test 1, the compacted refuse was consumed slightly slower than non-compacted; however, the reverse is true in the results of Test 2. One must conclude that these differences are of no real significance. Likewise, the results of weight reduction calculations are contrary in the two test runs.

In summary, comparative data reveals no significant differences in the burning characteristics of compacted versus non-compacted refuse. In the rotary kiln type unit used in the tests, it is obvious that temperatures between 1600°F and 1800°F are adequate for complete burning. Any differences in the rate at which refuse is consumed is determined mainly at the discretion of the operator and not due to compacted refuse. After testing 85 tons of compacted material in the incineration process, no problems and no difference in incineration characteristics of compacted refuse were found. However, in comparison of the landfill disposal method and the predisposal incineration process certain facts are relevant. Compacted refuse can be disposed of in less space than required for non-compacted refuse, a critical factor when many cities are running low on land suitable for landfills. At $6.00 a ton to incinerate solid waste in Atlanta (page 101) as opposed to $.94 (page 74) a ton to landfill the same solid waste, the most efficient and economical method of disposing compacted refuse is landfill disposal.

C. Advantages and Disadvantages of Varying Types of Collection Techniques

During this section discussion will center on the possible advantages and disadvantages of varying types of collection techniques. Backdoor collection of compacted refuse will be compared to collection of non-compacted refuse. Curbside collection of compacted refuse will be documented in comparison to curbside collection of non-compacted refuse. The pros and cons of backdoor collection and curbside collection in and for the City of Atlanta will be examined. Some brief attention will be directed to the open bed truck curbside method of collecting compacted refuse as opposed to compactor truck curbside method and compactor truck backdoor method collection of the same.

1. Comparison of Collection of Non-compacted Refuse to Collection of Compacted Refuse

When collecting compacted refuse, that is, refuse from homes using the household compactor, it is possible to reduce service from two days a week to one day a week with resultant reduction in costs. The residents have no important problems in connection with service once a week and many preferred collection once a week backdoor as opposed to curbside collection. One-third of the residents preferred curbside collection once a week, instead of two times a week. See Tables II, III and IV.

TABLE II

BACKDOOR COLLECTION
EAST LIDDELL WEEKLY AVERAGES

Equipment: 1 compactor truck, 2 satellite vehicles
Crew: 1 collection driver, 2 satellite vehicle drivers
Time is calculated in hours and tenths of an hour.
Definitions are in Appendix C

Item	Collection 2/t Wk. Base Data		Collection 1/t Wk. Demo Data	
Total route time	8.0		3.9	
Time collecting	14.4		7.1	
Clean up time	1.1		.6	
Wait time	.1		.05	
Ride time	.1		-	
Lost time	.08		.05	
Break down time	.08		-	
Productive time (lbs./hr.)	942		1842	
Total time	15.9		7.8	
Total stops	467		230	
Total pounds	13,660		13,081	
Time Per Stop	.03		.03	
	Man 1	Man 2	Man 1	Man 2
Number stops	230.5	236.5	113.6	115.3
Time collecting	7.3	7.1	3.6	3.5
Clean up time	.6	.6	.4	.2
Wait time	.1	-	.05	-
Ride time	.1	-	-	
Lost time	.1	-	-	.05
Total	8.2	7.7	4.05	3.75

TABLE III

CURBSIDE WEEKLY AVERAGES

Equipment: 1 compactor truck
Crew: 1 collection driver, 2 collectors
Time is calculated in hours and tenths of an hour.

Item	Collection 2/t Wk. Base Data	Collection 1/t Wk. Demo Data
Total route time	6.2	3.8
Time collecting	3.0	1.7
Clean up time	.1	.2
Wait time	.1	-
Ride Time	2.3	1.4
Pack time	.5	.3
Lost time	.2	.2
Productive time (lb./hr.)	3434	6077
Total time*	6.2	3.8
Number stops	556	329
Total pounds	18,202.5	18,840
Time Per Stop	.01	.01
Time Per DU**	.02	.01

*Total time does not include total route time. Definitions are in Appendix F.
**DU is based on 380 dwelling units.

TABLE IV

BACKDOOR COLLECTION
WEST MADDOX WEEKLY AVERAGES

Equipment: 1 compactor truck
Crew: 4 collectors, 1 collection driver
Time is calculated in hours and tenths of an hour.

Item	Collection 2/t Wk. Base Data				Collection 1/t Wk. Demo Data			
Total route time	3.4				1.3			
Time collecting	8.9				4.0			
Clean up time	.6				.3			
Wait time	1.1				.3			
Ride time	.8				.4			
Lost time	.3				.2			
Productive time	.5				.02			
(lbs./hr.)	786				1872			
Total time	12.4				5.2			
Total stops	294				128			
Total pounds	7620				8238			
Time Per Stop	.04				.04			
	Man 1	Man 2	Man 3	Man 4	Man 1	Man 2	Man 3	Man 4
Number stops	81	63	90	60	37	32	32	30
Time collecting	2.3	2.0	2.5	2.1	1.0	1.0	1.0	1.0
Clean up time	.1	.1	.2	.1	.09	.08	.1	.05

Definitions are in Appendix E.

In each case, only one day is required to collect approximately the same number of pounds of refuse. Servicing the route one day each week instead of the normal two day collection reduces collection cost by more than half for backdoor collection and by almost half for curbside collection.

Average Collection Cost
City of Atlanta

Route	Demo & Base Cost Per Hour	Demo* & Base Cost Per Day	Base** Per Week
East Liddell - Backdoor*** 2 satellite vehicles	$14.73	$117.80	$235.60
West Maddox - Backdoor**** 4 man walking crew	$19.31	$154.42	$308.84
Entire Route - Curbside***** 2 man walking crew	$12.81	$102.42	$204.84

*Demo - collection of compacted refuse one time a week.
**Base - collection of non-compacted refuse twice a week.
***East Liddell cost table is on page 44.
****West Maddox cost table is on page 48.
*****Entire route cost table is on page 53.

Backdoor Collection For The Route	Base Cost Per Hour
East Liddell 2 satellite vehicles	$14.73
West Maddox 4 man walking crew	19.31
	$34.04 ÷ 2 = $17.02 cost

per hour to collect refuse at the backdoor on the project route.

Backdoor Collection
Non-compacted Refuse

East Liddell (Backdoor) 15.9* average hours to collect route
West Maddox (backdoor +12.4* average hours to collect route
28.3 average hours to collect project
route backdoor two times a week of non-compacted refuse.

$17.02 (cost per hr.) x 28.3 (no. hrs.) = $481.67 average cost to collect non-compacted refuse at the backdoor twice a week.

Cost per dwelling unit (380 units) is $0.58 a week.

*15.9 on Table II
*12.4 on Table IV

Backdoor Collection
Compacted Refuse

East Liddell(Backdoor) 7.8* average hours to collect route
West Maddox (Backdoor) +5.2* average hours to collect route
13.0 average hours to collect compacted refuse one time a week
at the backdoor on the project route.

$17.02 (cost per hr.) x 13 = $221.26 average cost to collect compacted refuse at the backdoor once a week on the project route.

Cost per dwelling unit (380 units) is $0.58 a week.

*7.8 is on Table II
*5.2 is on Table IV

Curbside Collection of Non-Compacted and Compacted Refuse

Entire Route $12.81* average cost per hour to collect.

$12.81 x 6.2 (no. hrs.)* = $79.42 average cost per week to collect non-compacted refuse curbside twice a week on the project route.

Cost per dwelling unit (380 units) is $0.21 a week.

*$12.81 - page 53
**6.2 on Table III

$12.81 (cost per hr.) x 3.8* (no. hrs.) = $48.68 average cost to collect compacted refuse curbside once a week.

Cost per dwelling unit (380 units) is $0.13 a week.

*3.8 is on Table III.

2. Comparison of the Backdoor Collection Method to Curbside Collection of Non-Compacted Refuse

In the preceding section primary savings are achieved by utilizing the household compactor and collecting one time a week instead of the normal two times a week. This section compares data on curbside and backdoor collection of non-compacted refuse two times a week. See Table V for the considerable time saving evident during curbside collection.

Utilizing the average time to collect non-compacted refuse twice a week at the backdoor and curbside the following costs are deducted.

Method	Time	Cost
Curbside Collection*		
(2 times week - noncompacted refuse)	6.2 hrs.	
2 man walking crew - 1 truck driver	at $12.81 an hr. =	$79.42 week
Cost per dwelling unit is $0.21		
Backdoor Collection*		
(2 times week - noncompacted refuse)	28.3 hrs.	
4 man walking crew - 1 truck driver	at $17.02 an hr. =	$481.67 week
Cost per dwelling unit is $1.27		

*Curbside and backdoor costs are explained on page 23.

Cost is based on actual time to collect these routes. The curbside method of collecting non-compacted refuse twice a week is one-fifth the cost of backdoor collection of the same route non-compacted refuse twice a week.

3. Comparison of Backdoor and Curbside Collection of Compacted Refuse Collected One Time a Week

The considerable time and cost savings evidenced in curbside collection of non-compacted refuse as opposed to backdoor collection of non-compacted refuse is reinforced in the comparison of backdoor and curbside collection of compacted refuse. See Table VI.

Utilizing the average time to collect compacted refuse once a week, the following costs are shown.

TABLE V.

COMPARISON OF BACKDOOR TO CURBSIDE COLLECTION
NON-COMPACTED REFUSE
BASE DATA

WEEKLY AVERAGE

Item	Entire Route Curbside*	W. Maddox - E. Liddell Backdoor**
Total route time	6.2	11.4
Time collecting	3.0	23.3
Clean up time	.1	1.7
Wait time	.1	1.2
Ride time	2.3	.9
Pack time	.5	.3
Lost time	.2	.58
Break down time		.08
Productive time (lbs./hr.)	3434	879
Total time***	6.2	28.3
Total stops	556	761
Total pounds	18,202.5	21,280
Time Per Stop	.01	.04
Time Per DU	.02	.07
(380 dwelling units)		

*Curbside definitions are in Appendix F.

**Backdoor definitions are in Appendix C and E.

***Total time does not include time collecting during the W. Maddox backdoor collection.

Method	Time	Cost
Curbside Collection* (1 time a week - compacted refuse) 2 man walking crew - 1 truck driver Cost per dwelling unit is $0.13 a week.	3.8 hrs. at $12.81 hr. =	$48.68 week
Backdoor Collection* (1 time a week - compacted refuse) 2 satellite vehicles - 1 truck driver 4 man walking crew - 1 truck driver Cost per dwelling unit is $0.58	13.0 hrs. at $17.02 per hr. =	$221.26 week

*Curbside and backdoor collection costs are explained on page 23.

4. Comparative Costs

Presently the City of Atlanta Sanitation Department collects refuse at the backdoor two times a week using either a compactor truck and walking crew or the compactor truck and satellite vehicles. During the Atlanta Household Refuse Compactor Demonstration Project, data was obtained on the collection of non-compacted refuse using varying crews and collecting at the backdoor as well as curbside. The same procedure was used during the test collection of compacted refuse.

Savings in cost to the city become evident in two areas:

(1) Comparative costs of non-compacted refuse collected at the backdoor twice a week to curbside collection of the same.

Route	Per Week Lbs. Collected	Per Week Ave. Tons	Cost To Collect	Cost Per Ton
Backdoor Entire Rt.	21,280*	10.6	$ 481.67	$ 45.44
Curbside Entire Rt.	18,202.5**	9.1	$ 79.42	$ 8.73

*21,280 is on Table V
**18,202.5 is on Table III

Presently the City of Atlanta is paying $45.44 a ton to collect refuse at the backdoor twice a week on this route.

Conclusion: Curbside collection twice a week of non-compacted refuse would result in a savings of $36.71 a ton to collect this route each week.

TABLE VI

COMPARISON OF BACKDOOR TO CURBSIDE COLLECTION
COMPACTED REFUSE
DEMO DATA
WEEKLY AVERAGE

Time is calculated in hours and tenths of an hour.

Item	Entire Route Curbside	W. Maddox - E. Liddell Backdoor
Total route time	3.8	5.2
Time collecting	1.7	11.1
Clean up time	.2	.9
Wait time	-	.35
Ride time	1.4	.4
Pack time	.3	.2
Lost time	.2	.07
Productive time (lbs./hr.)	6077	1854
Total time	3.8	3.0
Total stops	329	361
Total pounds	18,840	21,319
Time Per Stop	.01	.04
Time Per DU (380 units)	.01	.03

(2) Comparative cost of compacted refuse collected at the backdoor once a week to curbside collection of the same.

Route	Lbs. Collected	Weekly Average Ave. Tons	Cost To Collect	Cost Per Ton
Backdoor Entire Rt.	21,319*	10.6	$221.26	$20.87
Curbside Entire Rt.	18,840*	9.4	$48.68	$5.18

*See Table VI

Conclusion: Curbside collection of compacted refuse one time a week would result in a collection savings of $15.69 a ton to collect this route.

Conclusion: Total savings for the City of Atlanta utilizing curbside collection once a week of compacted refuse at $5.18 a ton instead of backdoor collection twice a week of non-compacted refuse at $45.44 a ton would be $40.26 a ton.

5. Comparison of Segments During Curbside Collection of Compacted and Non-Compacted Refuse

Segment comparison of curbside collection of compacted and non-compacted refuse substantiates the previously mentioned variables in the amount, not volume, of refuse collected as well as the time involved in collection. See Table VII. During collection of compacted refuse an average of 12.5 cans per week are handled as opposed to an average of 20 cans per week during collection of non-compacted refuse. An average of seven bags per segment are handled during collection of compacted refuse and an average of 18 bags per segment are handled during collection of non-compacted refuse. Collection time per segment during collection of compacted refuse was three minutes 20 seconds as compared with six minutes 15 seconds to collect non-compacted refuse.

6. Comparison of Curbside Collection of the Open Bed Truck to the Compactor Truck During Curbside and Backdoor Collection of Compacted Refuse.

As previously stated, use of the open bed truck was a most undesirable method of collection. It was not safe, it was time consuming, more tedious and more trips were required to take the refuse to the disposal site. For more data on the open bed truck method of collection see pages 104-107 and Table VIII.

Conclusion: Any incorporated area utilizing the open bed truck would be well advised to discontinue this method of collection and add the compactor truck before consideration of the household compactor within its system. Curbside collection two times a week is a desirable prelude to the addition of a household compactor within the solid waste collection system.

TABLE VII

COMPARISON OF COMPACTED AND NON-COMPACTED REFUSE BY SEGMENTS

Item	Compacted* — 28 Segments			Noncompacted* — 28 Segments		
	Total	Avg/Seg	Avg/DU**	Total	Avg/Seg	Avg/DU
Stops/Week	298	11	-	529	19	-
Cans/Week	349.2	12.5	.9	551	20	1.5
Bags/Week	195.05	7	.5	502.75	18	1.6
Odds/Week	208.38	7	.5	111.50	4	.3
Collection Time	1:33:23	3:20	:14	2:41:07	6:15	:25
Travel Time	1:18:39	2:27	:12	1:59:45	4:28	:18
Clean-Up	13:48	:29	:02	14:20	:52	:02
Pack Time	18:31	:39	:02	18:27	1:07	:02
Cost Time	5:12	:11	:01	12:12	:43	:01

*Data for each segment is found on Table XVIII, Compacted Refuse and Table XII, Non-compacted Refuse.

**DU is 380 dwelling units.

TABLE VIII
COMPARISON OF OPEN BED TRUCK CURBSIDE
TO
COMPACTOR TRUCK CURBSIDE
TO
BACKDOOR COLLECTION

Item	Open Bed Truck Curbside Compacted Refuse 1 driver - 2 men	Compactor Truck Curbside Compacted Refuse 1 driver - 2 men	Compactor Truck Backdoor Compacted Refuse 1 driver - 4 men
Total route time	4.7	3.8	1.3
Time collecting	2.6	1.7	4.0
Clean up time	.3	.2	.3
Ride time	1.5	1.4	.4
Wait time	-	-	.3
Pack	-	-	.2
Lost time	.1	.2	.02
Productive time (lbs./hr.)	3750	6077	1872
Total time	4.5	3.8	5.2
Total stops	310	329	128
Total pounds	15,373	18,840	8238
Time Per Stop	.01	.01	.04

D. Advantages and Disadvantages of the Compactor as a Part of a System Approach to Metro Trash Collection

Imagine, if you will, a city of 50,000 people. Each person in Metro* generates an average of five pounds of solid waste each day. In toto, 875 tons of refuse is generated each week. Presently this refuse is collected twice a week at the backdoor. Collection is accomplished by compactor trucks, satellite vehicles, and walking crews making use of the appropriate method in the appropriate area. Metro presently employs two methods of disposal, the sanitary landfill and the incinerator.

Collection costs are mounting. Appropriate land for disposal sites is diminishing. Incineration of wastes is expensive and a source of pollution in the atmosphere and the water. Year by year the amount of refuse generated by each person is increasing.

Metro needs to cut cost of collection and provide a more efficient method of handling refuse. Heretofore, the residents have resisted a change from backdoor to curbside collection but..........something must be done.

Current collection costs for Metro are shown on the following chart.

Collection	Cost Per Ton	Weekly Cost 875 tons Cost Per Ton	Yearly Cost 45,500 tons Cost
Backdoor (2 times a week)	$45.44**	$39,760.00	$2,067,520.00

If Metro collected curbside instead of backdoor, cost would be:

Collection	Cost Per Ton	Weekly Cost 875 tons Cost Per Ton	Yearly Cost 45,500 tons Cost
Curbside (2 times a week)	$8.73***	$7,638.75	$397,215.00

$1,670,305.00 each year could be saved if Metro utilized the curbside method of collection twice a week.

*Metro is an econometric model of a municipality of 50,000 persons using compactors in a solid waste collection system.

**Figure based on cost to collect project route backdoor two times a week, non-compacted refuse, City of Atlanta. See p. 26.

***Figure based on cost to collect project route curbside two times a week, non-compacted refuse, City of Atlanta. See p. 26.

However, a new device has been marketed for the homeowner to help maintain the volume of trash at a controllable level. The household refuse compactor reduces volume of refuse at the source so there are fewer trashcans to handle, fewer trips to the trashcan and, in general, less mess. Does the compactor reduce the volume of refuse by half? If so, would it be possible to collect refuse one day a week instead of two?

In order to find out how the compactor functions within a solid waste collection system, Metro set aside a collection route for a demonstration project. Metro tested the compactors in the homes of residents providing varying types of collection service but collecting only once a week. The project proved collection of compacted refuse can be accomplished once a week. The majority of residents complained of curbside collection because of dogs getting into the trash, weight of the bags and because the cans looked messy on the street. Most preferred backdoor collection but practically all agreed curbside collection was easier with the compactor in the home.

Metro then asked, "Is it possible for the city to purchase and install compactors in order to effect collection one time a week?" "What are the costs and what are the benefits?"

Using the 1970 U.S. Census figure of 3.19 persons per household, the 50,000 people in Metro would makeup 15,674 households. Each household would require a compactor. Cost of the compactor is $140.00[1] each if ordered in carload lots of 208 compactors. The $140.00 figure includes shipping anywhere in the United States and one year parts and service warranty. An additional figure of 75c[2] each month per compactor should be included to cover cost of service, maintenance and scrap-out.

If the 15,674 compactors necessary to provide each home with a unit were ordered two problems would arise: (1) Location, where to store the units until they can be delivered and (2) available crews to install the units. One crew, two men and a driver, can install approximately 50 compactors a week.

Metro is going to use five crews to install the compactors in the homes. One thousand compactors can be installed each month. Every month an order will be placed for five carload lots of compactors until 76 carloads have been ordered. An extra 134 units will have been ordered but these units will be needed on hand as scrap-out occurs or loss by theft or fire. The order is placed every month because the city has no space available for storage of more than 1,040 compactors. By the arrival date of the new lot, the first lot of compactors would have been installed.

Cost

208 compactors per carload lot
$140 each compactor
76 carload lots
$2,213,120 total cost
At 6% over 8 years* the cost would be $29,278 a month or $1.85 a unit.

*Expected life of the compactor.

[1] Correspondence from the Whirlpool Corporation dated 8-28-73.

[2] Willman, Martha. "Trash Collector Gives Compactors to Homes." Los Angeles: Los Angeles Times, Feb. 11, 1973, V., p. 4.

In addition to compactor cost, installation cost must be considered.

Installation Cost

Item	Per Week
5 supervisors @$225.00	$1125.00
1 Clerk @$150.00	150.00
Drivers (5) @$171.87	859.35
Crew (5) @$312.74	1563.70
Truck (5 open bed) @$26.39 each	131.45
Total	$3829.50

$3829.50 (cost per week for 5 crews) x 4 =$15,318 (cost per month for 5 crews) x 16 months to install = $245,088.00 total installation cost.

Five crews were used in Metro. These crews can install 1000 compactors each month and approximately 16 months will be needed to install the 15,674 compactors to be used. In the formulas shown on the following pages, installation cost is show as **It** and the total cost of installation is computed within the first year. The second through the eighth years the $245,088 can be added to the total savings figure.

A figure of 75c per month per compactor must be added to take care of service, maintenance and scrap-out. Total service and maintenance figure each year is $141,066.

For a city the size of Metro, 50,000 persons or 15,674 households, it would cost $2,213,120 to place compactors in each home plus installation cost of $245,088 and service and maintenance cost of 75c per compactor per month or $141,066 per year.

Cost of collection of compacted refuse is $20.87 a ton once a week at the backdoor and $5.18 a ton once a week curbside.* Cost of non-compacted refuse per ton collected at the backdoor twice a week is $45.44 and cost of non-compacted refuse per ton collected at the curbside twice a week is $8.73.

Current Cost

Collection	Cost Per Ton	Tons Per Year	Yearly Cost
Backdoor (2 times a week)	$45.44	45,500	$2,067,520
Curbside (2 times a week)	8.73	45,500	397,215
		Difference	$1,670,305

$1,670,305 annual savings possible by using curbside collection two times a week instead of backdoor collection.

*See page 26.

Proposed Cost

Collection	Cost Per Ton	Tons Per Year	Yearly Cost
Backdoor (1 time a week)	$20.87	45,500	$949,585
Curbside (1 time a week)	5.18	45,500	235,690
			Difference $713,895

$713,895 annual savings possible using the curbside method of collection of compacted refuse 1 time a week instead of backdoor collection of compacted refuse one time a week.

Utilizing the following definitions, formulas for determining varying collection costs can be devised.

B^2 = Backdoor collection of non-compacted refuse two times a week. $2,067,520

B^1 = Backdoor collection of compacted refuse one time a week. $949,585

C^2 = Curbside collection of non-compacted refuse two times a week. $397,215

C^1 = Curbside collection of compacted refuse one time a week. $235,690

S = Savings

CCpy = Cost of compactors per year. $351,336

It = Installation total cost. $245,088

Spy = Savings per year.

SM = Service and Maintenance per year. $141,066

CONCLUSIONS

$$B^2 - C^2 = Spy$$

$2,067,520 - $397,215=$1,670,305 annual savings possible in Metro using curbside collection two times a week instead of backdoor collection two times a week.

$$(B^2 - B^1) - (CCpy + It + SM) = Spy$$

($2,067,520 - $949,585) - ($351,336 + $245,088 + $141,066)=$380,445 savings per year possible by changing from backdoor collection two times a week of non-compacted refuse to backdoor collection one time a week of compacted refuse including cost of the compactors for the year and total installation cost. The second through the eighth year an additional $245,088 or a total of $625,533 each year could be saved because there are no installation costs.

$$(B^2 - C^1) - (CCpy + It + SM) = Spy$$

($2,067,520 - $235,690) - ($351,336 + $245,088 + $141,066) = $1,094,340 savings possible each year by converting from backdoor collection of non-compacted refuse two times a week to curbside collection of compacted refuse one time a week. Figure includes cost of compactors for the year. An additional $245,088 savings each year or a total of $1,339,428 could be saved years two through eight because there is no installation cost during these seven years.

Benefits of curbside collection one time a week utilizing the compactor in the home include:

(a) Noise pollution is lower. Rattling cans, dogs barking, truck starting and stopping and compacting is noisy. This would occur only once a week instead of twice.

(b) Accident potential is reduced.

(c) Streets are littered only once a week.

(d) Wear and tear on streets by trucks is reduced.

(e) Traffic congestion is lessened.

(f) Fifty percent more compacted refuse can be placed in a sanitary landfill than non-compacted refuse.

(g) Resident takes refuse to the curb only one time a week and has fewer bags to handle.

(h) Municipalities would be able to better cope with the declining labor force.

(i) Inventory of equipment on hand could be reduced.

(j) Approximately half as much fuel would be required to operate vehicles.

E. Recommendations

The City of Atlanta is disbursing far too much revenue to collect solid waste. Such expenditure is unnecessary. An immediate change in the method of collection from backdoor twice a week to curbside twice a week would affect considerable savings. In order to obtain the fullest measure of economy and efficiency, it is recommended the City immediately stop backdoor collection twice a week and begin curbside collection twice a week aiming toward a goal of collecting compacted refuse curbside once a week.

To achieve the goal of collecting compacted solid waste once a week curbside, the following measures are recommended:

1. The City of Atlanta should strictly enforce the dog leash law. In the project area many families own more than one dog and the dogs are allowed to roam unsupervised. These dogs are a positive public nuisance and should be controlled.

2. Residents within the City should be informed:

(a) Curbside collection twice a week will begin at once. Set a date within a few weeks.

(b) During the next two to three years compactors will be available for sale for a limited time by the City to aid the resident with curbside collection and pave the way for curbside once a week.

(c) Announce target date for curbside collection one time a week. Ideally within three to five years of changeover from B^2 to C^2.

3. A wheeled vehicle should be used by the resident to take refuse to the curb. The resident should be informed of the advantages of such a vehicle. The Sanitation Services Division should urge local stores to make such vehicles available for sale to residents. These vehicles would relieve some of the dissatisfaction with the curbside method of collection when the changeover from B^2 to C^2 occurs. The weight and bulk of trash would not be a factor and the trip to the curb would not be as unpleasant during inclement weather. The elderly would not be required to lift or carry.

4. Initiate a program plan whereby compactors could be made available and restricted to the residents of the City of Atlanta presently receiving household collection service. Such a plan should be organized by service routes. Compactors would be placed at neighborhood centers for sale by the City and pickup by the resident. The City of Atlanta would pay half ($70.00) of the compactor cost and the resident would pay half, $70.00.

5. Amend the building code to require compactors and food waste disposers in all new residential construction.

6. Once the target date for changeover from C^2 to C^1 is met, the City of Atlanta should terminate the compactor sale operation. Any future purchases of compactors by city residents should be accomplished elsewhere.

7. The sanitary landfill method of disposal is recommended for compacted refuse. Fifty percent more compacted waste can be placed in the same volume of non-compacted refuse leading to far more efficient land use.

Utilizing this approach, all residents would be aware curbside collection once a week was eminent. The resident could elect to purchase the compactor during the availability interim or he could simply purchase additional cans.

The City of Atlanta would not be plagued with a large outlay of funds because initial savings from B^2 to C^2 would supply the necessary revenue for compactor cost. The resident would pay half the cost, own the compactor and assume liability for ownership, maintenance and replacement. By distributing the compactors from neighborhood centers and allowing the resident to pick up the unit, delivery and installation costs are reduced. The City would not have to obtain permission to place compactors in resident's homes. Ownership would become strictly a resident decision.

8. Specific Recommendations

The compactor overall was judged by the residents as quite a success. Some specific items however, should be improved.

(a) Compactor bags should be fitted with some sort of tie in order to seal them securely before collection.

(b) The compactor was not designed to replace the food waste disposer and if used in conjunction with a disposer, results are very satisfactory. Otherwise, items such as meat, chicken or fruit waste should not be placed in the compactor.

(c) The best location for the compactor is in the kitchen under the counter beside the sink.

(d) The compactor bag should be packed according to manufacturer's instructions and handled with care to avoid accidents, as sharp objects will penetrate the bags.

(e) Waste collectors should not throw or toss compactor bags and should wear gloves.

Stage 1.

The purpose of the first stage of this project was to obtain all meaningful data possible prior to the installation of the compactor in each home in order to have a base which later could be used in comparison with demonstration data collected once the compactor was in the home. A test route had to be selected and contracts had to be obtained from each household agreeing to participate in the study before data could be obtained of normal working conditions on the collection route. Once contracts were signed, base data, that is, data relating to normal collection for the route prior to the installation of the compactors, was collected. After base data was completed compactors were placed in the homes and a survey team member completed Questionnaire I.

A. The Test Route and the Contract

1. Selection of the Test Route

Five areas in the city were recommended by the Sanitation Services Division as possible and workable neighborhoods for the project. The areas were visited and it was determined a southwest area known as Cascade Heights (approximately 95 percent black) and a northwest area, Margaret Mitchell (98 percent white), were the only areas suitable for the demonstration.

These areas were chosen for several reasons. A stable neighborhood to minimize change of participation by residents in the demonstration was important. Selection of a neighborhood which was middle income in character was desirable in order to represent homeowners most likely to purchase the equipment under normal circumstances. Location and distance to suitable landfill and incinerator sites were important considerations. The educational level of the inhabitants was as important as an area where it was not necessary for both husband and wife to work in order to handle finances. With these factors in mind, search continued for a better racial balance. However, in areas having relatively equal racial balance, a high degree of transition was taking place. The transition factor was unacceptable because of technicalities involved in placing the compactors in the homes, moving the units from home to home and questionnaire response could not reflect continued use. The possibility of using 200 homes in the southwest area and 200 homes in the northwest area to achieve racial balance was discussed. The requirements of additional time and employees made this scheme undesirable. Actual savings as well as time and motion data would be distorted to a considerable degree. A decision between the southwest area and the northwest area had to be made and it was decided to allow residents of the respective areas to make this decision.

2. Project Promotion

In order to help the resident with this decision, the public relations phase of the project was initiated. It was essential to project success that users of the compactor sign a contract with the City of Atlanta and cooperate throughout the study period. In order to assure willingness on the part of the household occupants, all phases of public relations were purposefully designed to assure cooperation.

The public in general and the head of the household in particular must be assured of the validity of the Atlanta Household Refuse Compactor Demonstration Project. An announcement of the demonstration project and the importance of the test route was made by Mayor Sam Massell at a press conference in Atlanta. Local radio, television and press personnel were present as well as reporters from three national magazines and the Associated Press. The Mayor stressed the importance of the demonstration to the city and the nation and tried to impress the

Preceding page blank

public by emphasizing the honor and privilege connected with the study. The 400 families on the test route would be fortunate, stated the Mayor, to have the opportunity to test the compactor and hopefully participate in the development of more economical and efficient trash collection methods. The press release is found in the Appendix under Item A.

One week after the press conference, 400 letters (Item B, Appendix) were mailed to residents in the northwest Atlanta area and the southwest Atlanta area. A stamped, self-addressed postcard was included in each letter for return by the resident stating whether or not he was interested in participating in the project. Selection of the test route was made on the basis of the most favorable response from the area. As of December 4, 1970, (date selection had to be made) total response was:

	N	Yes	No
Northwest route	400	49% (195)	4% (14)
Southwest route	400	39% (156)	2% (8)

Based on response received, the northwest route was selected. Figure 1 is a map of the test route. The analysis of Questionnaire I on page 56 provides a complete description of residents on the route.

3. Compactor Description

The survey team destined to make the initial contact with the householders on the test route met to see the compactor and a unit was demonstrated by the manufacturer's representative. Each member of the survey team was given an opportunity to examine and operate the machine.

The Whirlpool Trash Masher compactor used in this study was designed by the manufacturer to save up to a week's worth of trash in a bag, approximately the size of a grocery bag. It was designed to eliminate daily or semi-daily trips to the outdoor trash can and was advertised to end unsightliness and the bother of litter blowing over the yard.

According to the manufacturer, the compactor is easy to operate. The housewife opens the drawer, drops in the paper products, cans, bottles and household trash, then closes the drawer and presses the start button. When the drawer is closed, two sprays of deodorant are released into the drawer. This spray was developed to prevent odors. Once the spray is depleted, the ram, driven by one-third horsepower motor, moves down on twin screws exerting 2000 pounds of force compacting the contents. A key lock controls the electrical circuit and is an added safety device. Once the ram has started the downward thrust, the drawer cannot be opened unless the stop button is pushed. When the stop button is pushed, the ram returns to normal stop position and the drawer can be opened. The unit completes a cycle in approximately 60 seconds. When the bag is full, it is removed and carried to a location for pickup by the collection crew.

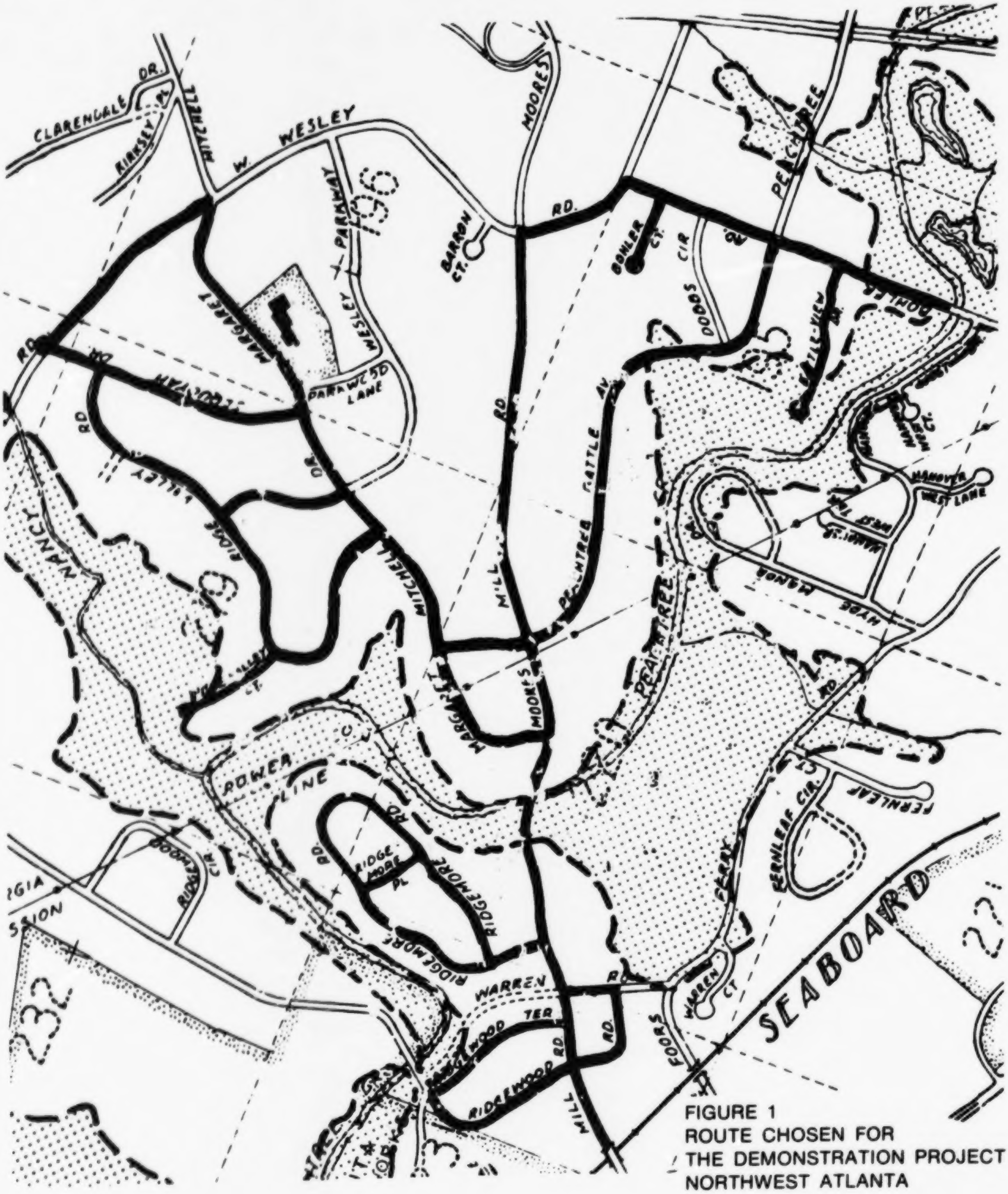

CLARENDALE DR.
KIRKSEY PL.
MITCHELL
W. WESLEY
PARKWAY
WESLEY
196
MOORES
BARRON CT.
RD.
BOHLER CT.
DODDS CIR
PEACHTREE
BOHLER
MARGARET
PARKWOOD LANE
PEACHTREE BATTLE AV.
MILL RD.
RIDGE VALLEY RD.
NANCY
MITCHELL
MARGARET
MOORES
HANOVER WEST LANE
HYDE MANOR
POWER LINE RD.
RIDGEMORE PL
RIDGEMORE RD.
FERNLEAF CIR.
FERNLEAF
PERRY
SEABOARD
WARREN RD.
WARREN CT
RIDGEWOOD TER.
RIDGEWOOD RD.
MILL RD.
FOORS
232
221

FIGURE 1
ROUTE CHOSEN FOR
THE DEMONSTRATION PROJECT
NORTHWEST ATLANTA

The manufacturer further states the compactor is a handsome appliance that can be installed under the counter or used free standing. No special equipment is needed for installation, just plug the unit into a standard wall plug. The unit operates for approximately 60c a year. Purchase of the bags and deodorizer is necessary. The bags are leakproof polyethylene lined, are packaged in sets of 12 at $3.99 a package, and should last the average family of four three months. One can of deodorizer spray ($1.99) should last four to five months.

Following demonstration of the compactor, the survey team was instructed as to the proper procedure to follow in personal contact with the resident. The contract between the City of Atlanta and the resident was explained to the group in order that they, in turn, could explain the contract to the residents.

4. The Contract

The survey team, within the time span of one week, attempted to contact all residents on the chosen test route and secure a contract with them. The contract was a simple agreement to allow placement of the compactor in the home with certain stipulations as to liability and contract dissolution.

Initial contact proved difficult and discouraging. Because of the season (Christmas) and various other reasons, it was extemely difficult to find residents at home. The problem was alleviated to some degree by telephone appointment and finally by leaving the contracts and information in the mailbox. Mail response was far better than expected. The press conference and introductory letter seemed to have been worthwhile. All residents were aware of the study and very few questioned the validity of the project.

An order was placed for 400 Whirlpool Trash Masher compactors, accompanying bags and deodorizer with the Whirlpool Corporation. Participants in the test area were permitted color preference and the units were ordered accordingly. The Whirlpool Corporation agreed to provide the compactors on consignment. Compactor bags and deodorizer were provided to the city for use during the study at a discount price and were free to project participants.

B. Investigate and Evaluate the Existing Collection System

Once the route was selected and the contracts had been obtained from the residents on the route, forms were designed to evaluate initial pickup at backdoor and for the curbside study of current collection techniques.

The test route chosen for this project was a combination of two separate and distinct refuse pickup routes. The routes were combined to obtain a representative cross-section. The east half of the route is normally serviced by a compactor truck and two satellite vehicles which are driven to the backdoor to effect collection. The west portion of the route is serviced by walking crews who carry refuse to the collection truck from the backdoor by means of a plastic "tote" barrel.

Base data was gathered on the test route utilizing the current or normal collection technique before installation of the compactor. Backdoor collection (two times a week) was undertaken for a period of four weeks on the east route and four weeks on the west route.

PHOTOGRAPH I
The "Trash Masher" Refuse Compactor Used in the Project

1. East Liddell Route (Base Data)

The east route, East Liddell, is slightly more than half of the entire route as indicated on Figure 2. The crew used to obtain the base data for this area consisted of the truck driver and two men operating satellite vehicles. Equipment consisted of a Loadmaster rear-loading, 20 yard capacity truck on a Chevrolet chassis with a two cubic yard hopper. Two satellite vehicles, one and one-half cubic yard International scouts, were also used. The Project Director used a wristwatch, stop watch and odometer to measure time and motion. Base data collected on the East Liddell route during four weeks and eight collection periods is shown on Table IX. Forms used during this collection are found under Item C in the Appendix as well as definitions applicable to Table IX.

Cost of backdoor collection twice each week prior to compactor installation for the East Liddell route using the compactor truck, two satellite vehicles and three drivers is as follows:

TOTAL COST

Item	Per Hour	Per Day	Per Week*
Truck	$ 2.63	$ 20.97	$ 41.94
Two satellite vehicles	1.64	13.18	26.36
Labor			
1 Waste collector Driver	3.68	29.45	58.90
2 Waste Collector III**	6.78	54.20	108.40
Total	$14.73	$117.80	$235.60

*Based on two eight hour days.

**Waste Collector III operates the satellite vehicle.

Basic cost tables for collection equipment and labor as prepared by the City of Atlanta are found in the Appendix, Item D.

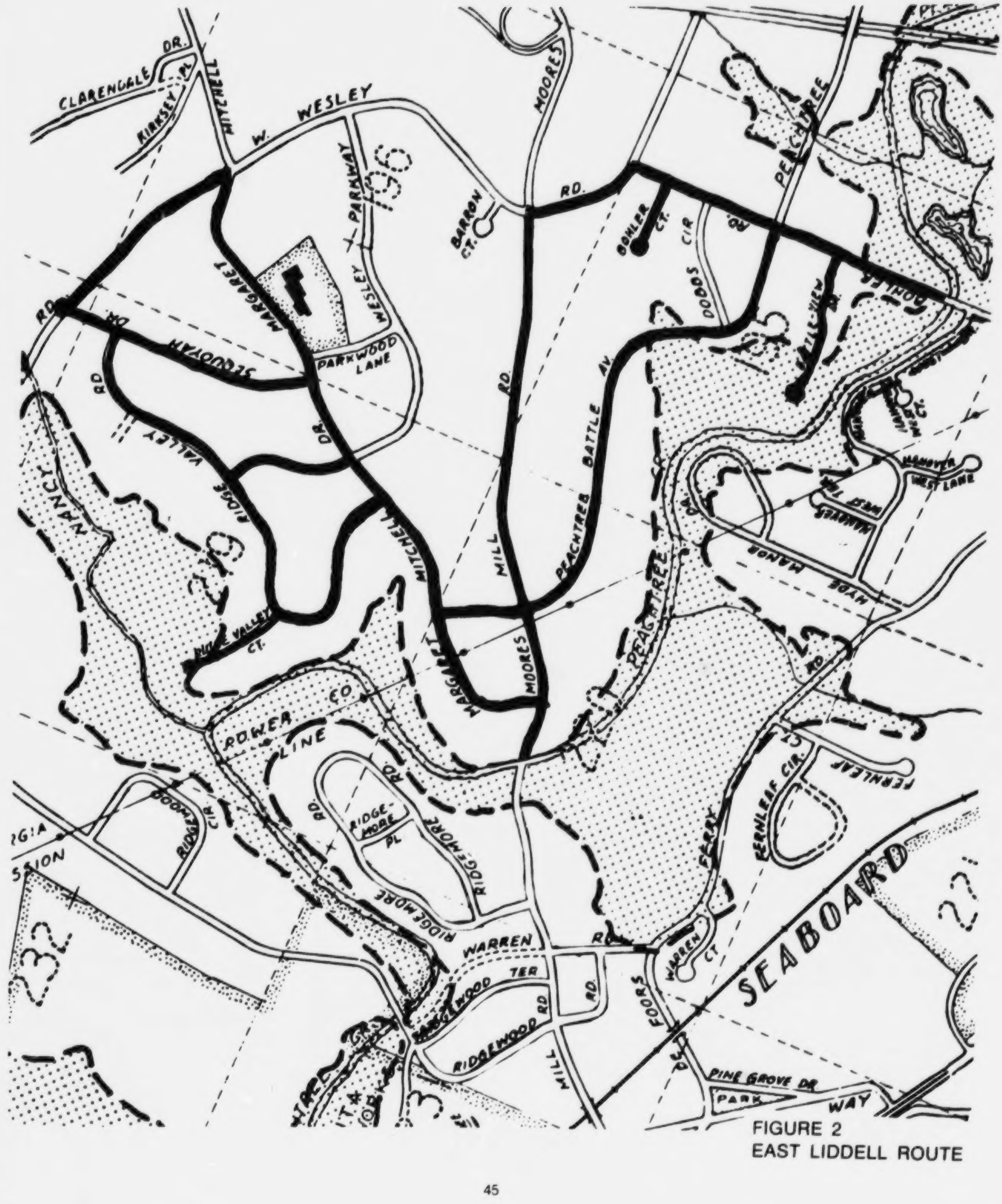

CLARENDALE DR.
KIRKSEY PL.
MITCHELL
W. WESLEY
MOORES
PARKWAY
WESLEY
196
BARRON CT.
RD.
BOHLER CT.
DODDS CIR.
PEACHTREE
RD.
BOHLER
MARGARET
PARKWOOD LANE
SEQUOYAH DR.
RD.
VALLEY
RIDGE
DR.
MILL RD.
PEACHTREE BATTLE AV.
NANCY
219
MITCHELL
PEACHTREE DR.
HANOVER WEST LANE
HYDE MANOR
RIDGE VALLEY CT.
MARGARET
MOORES
POWER CO. LINE
RD.
FERNLEAF CT.
FERNLEAF CIR.
RIDGEMORE PL.
RIDGEMORE RD.
RIDGEMORE
PERRY
SEABOARD
221
232
WARREN RD.
WARREN CT.
RIDGEWOOD TER
RIDGEWOOD RD
RD.
MILL RD.
FOORS
PINE GROVE DR
PARK WAY

FIGURE 2
EAST LIDDELL ROUTE

TABLE IX

EAST LIDDELL ROUTE
BACKDOOR COLLECTION
BASE DATA 4 WEEKS SUMMARY OF 8 COLLECTION PERIODS

Equipment: 1 compactor truck, 2 satellite vehicles
Crew: 1 waste collection driver, 2 satellite vehicle drivers.
Time is calculated in hours and tenths of an hour.

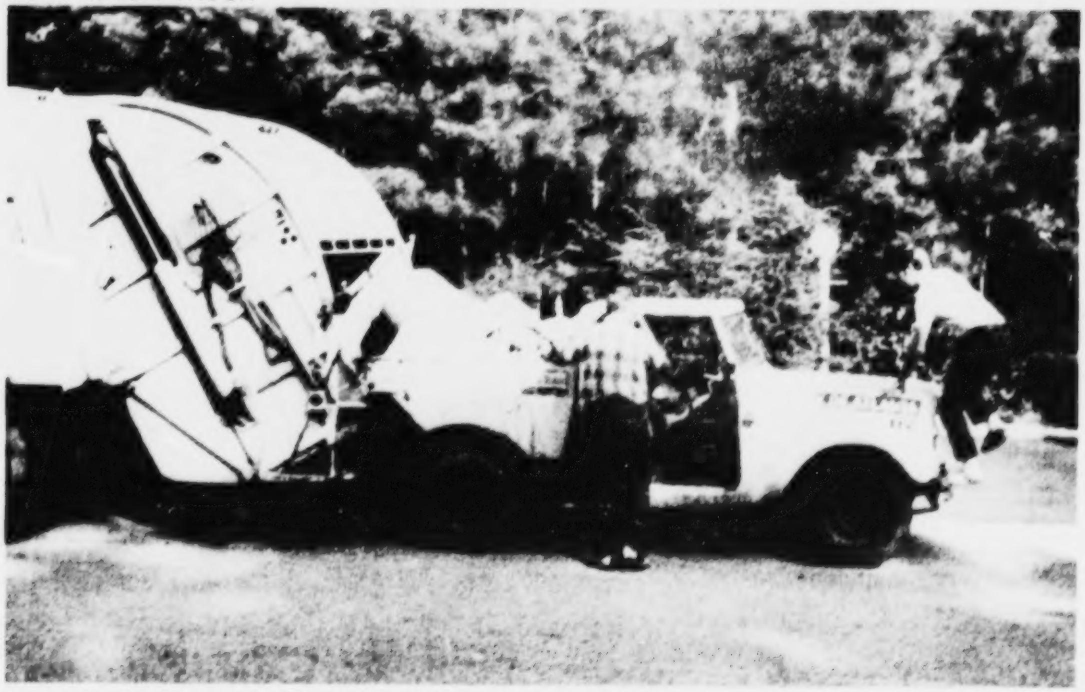
Collection Period	1	2	3	4	5	6	7	8	Total	Wk. Ave.
Total route time	4.5	4.2	4.2	4.3	3.7	4.6	3.8	3.7	33.0	8.0
Time collecting	8.2	7.3	7.7	7.6	6.6	8.1	5.6	6.6	57.7	14.4
Clean up time	.5	.7	.6	.6	.5	.7	.3	.5	4.4	1.1
Wait time		.1	.1		.1	.1			.4	.1
Ride time	.1			.1	.1		.1	.1	.5	.1
Lost time		.1	.2						.3	.08
Break down time						.3			.3	.08
Productive time (lb./hr.)	848	1014	919	888	776	1264	867	881		942
Total time	8.9	8.2	8.4	8.5	7.3	9.2	6.0	7.3	63.8	15.9
Total stops	232	234	237	239	226	233	227	240	1868	467
Total pounds	7040	7400	7080	6840	5200	10240	4940	5900	54640	13660
Time Per Stop	.03	.04	.03	.04	.03	.04	.03	.03		.03

Weekly Averages for Waste Collectors	Man 1	Man 2
Number stops	230.5	236.5
Time collecting	7.3	7.1
Clean up time	.6	.6
Wait time	.1	
Ride time	.1	
Lost time	.1	
TOTAL	8.2	7.7

*Productive time includes only time collecting and ride time.

CITY OF ATLANTA
SANITATION DIV

PHOTOGRAPH II
COMPACTOR TRUCK



PHOTOGRAPH III
SATELLITE VEHICLE DUMPING INTO COMPACTOR TRUCK

2. West Maddox Route

The west route, West Maddox, as shown on Figure 3, was serviced by a four man walking crew and a truck driver. The truck used was a Hobbs 20 yard capacity rear loader with a hopper capacity of one and one-half yard. A summary of backdoor collection base data on the West Maddox route for a period of four weeks, eight collection periods is shown on Table X. Forms used during this collection and definitions applicable to Table X are found in the Appendix under Item E.

Cost of backdoor collection of non-compacted refuse for the West Maddox route using the compactor truck and a four man walking crew is shown below:

TOTAL COST

Item	Per Hour	Per Day*	Per Week**
Truck	$ 2.63	$ 20.97	$ 41.94
Labor			
4 Waste Collector II***	16.68	133.45	266.90
Waste Collection Driver			
Total	$19.31	$154.42	$308.84

*Based on an eight hour working day.
**Based on two eight hour working days.
***Waste Collector II is a walking crewman.

Base cost of equipment and crew is found in the Appendix, Item D.

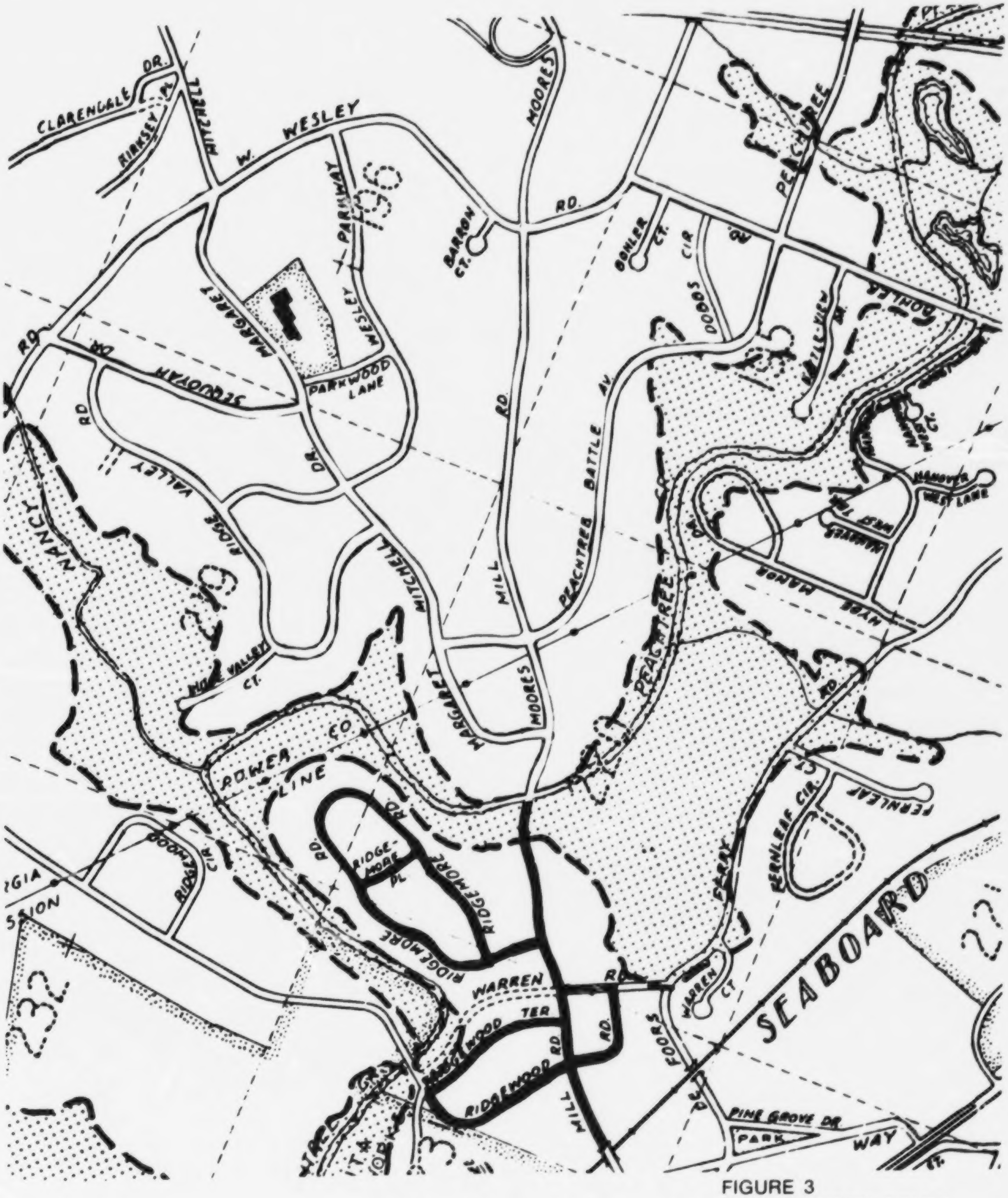

CLARENDALE DR.
KIRKSEY PL.
MITCHELL
W. WESLEY
RD.
PARKWAY
196
WESLEY
MARGARET
PARKWOOD LANE
SEQUOYAH DR
RD.
RIDGE VALLEY
NANCY
219
MITCHELL
DR.
VALLEY CT.
MOORES
RD.
BARRON CT.
MILL RD.
BOHLER CT.
DODDS CIR.
PEACHTREE
PEACHTREE BATTLE AV.
PEACHTREE DR.
BOHLER
MANOR
WEST LANE
POWER CO. LINE
MARGARET
MOORES
RIDGEMORE RD.
RIDGE-MORE PL
RIDGEMORE RD.
RIDGE CIR.
RGIA
SSION
232
WARREN RD.
RIDGEWOOD TER
RIDGEWOOD RD
RD.
MILL RD.
FOORS DR.
WARREN CT
FERRY
FERNLEAF CIR.
FERNLEAF
SEABOARD
221
PINE GROVE DR
PARK WAY

FIGURE 3
WEST MADDOX ROUTE

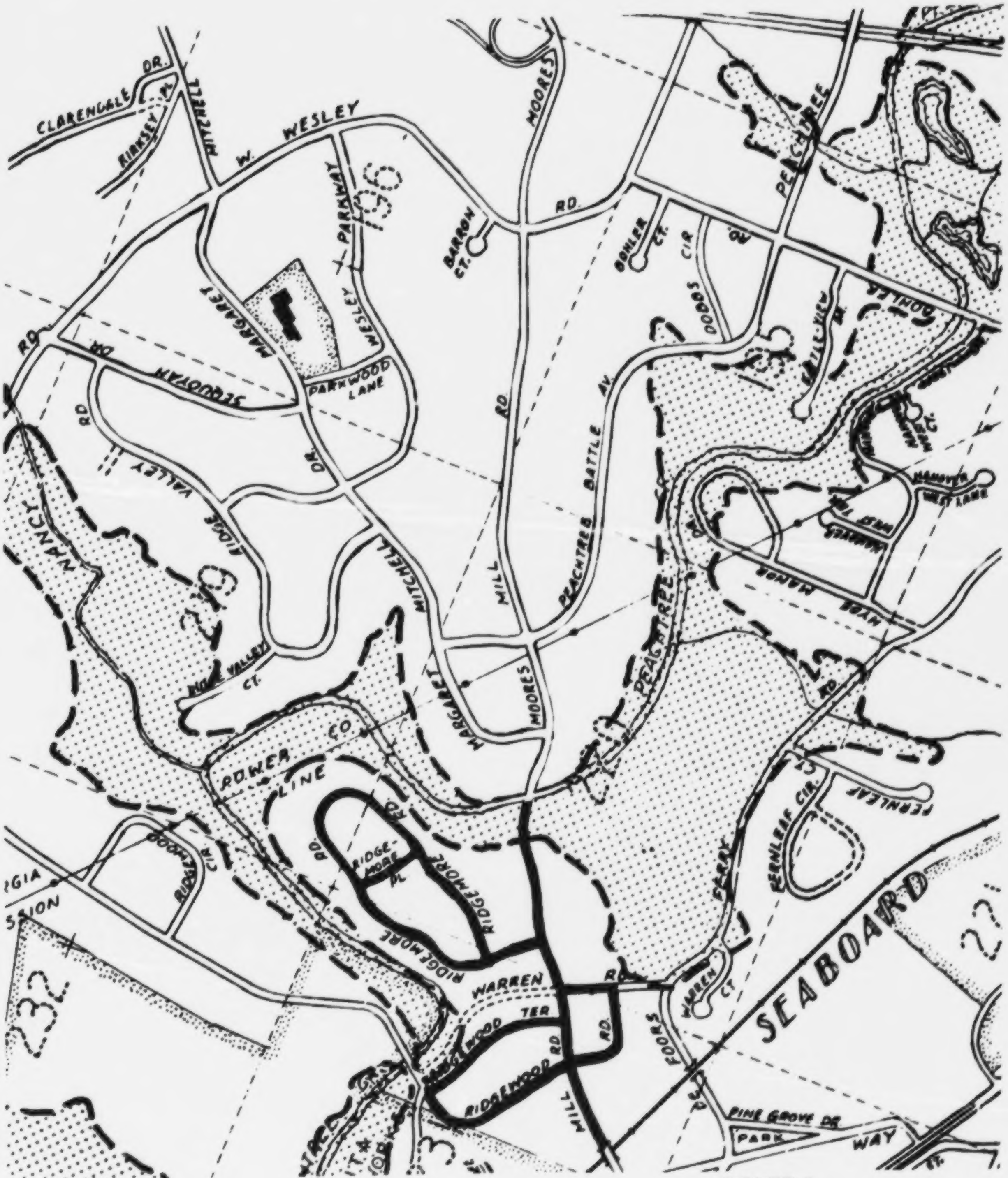

CLARENDALE DR.
KIRKSEY PL.
MITCHELL
W. WESLEY
PARKWAY
196
MOORES
BARRON CT.
RD.
BOHLER CT.
CIR.
PEACHTREE
MARGARET
WESLEY
PARKWOOD LANE
SEQUOYAH DR
RD.
VALLEY
RIDGE
NANCY
229
VALLEY CT.
DR.
MITCHELL
MILL RD
PEACHTREE BATTLE AV.
BOHLER
KNOLL VIEW
HANOVER
WEST LANE
HYDE MANOR
PEACHTREE DR.
MARGARET
MOORES
POWER CO. LINE
RIDGEMORE RD.
RIDGEMORE PL
RIDGEMORE RD.
RIDGE CIR
232
WARREN RD.
RIDGEWOOD TER
RIDGEWOOD RD.
MILL RD.
POORS
FERRY
WARREN CT.
FERNLEAF CIR.
FERNLEAF
SEABOARD
221
PINE GROVE DR
PARK WAY

FIGURE 3
WEST MADDOX ROUTE

TABLE X

WEST MADDOX ROUTE
BACKDOOR COLLECTION
BASE DATA 4 WEEKS SUMMARY OF 8 COLLECTION PERIODS

Equipment: 1 compactor truck
Crew: 4 man walking crew
Time is calculated in hours and tenths of an hour.

Collection Period	1	2	3	4	5	6	7	8	Total	Wk. Ave.
Total route time	1.6	1.5	1.6	1.3	2.2	1.4	2.4	1.5	13.5	3.4
Time collecting	3.6	3.9	4.6	3.2	6.3	4.2	5.6	4.5	35.9	8.9
Clean up time	.4	.2	.2	.1	.6	.2	.4	.3	2.4	.6
Wait time	.4	.7	.7	.4	1.0	.5	.3	.5	4.5	1.1
Ride time	.1	.3	.5	.5	.6	.4	.5	.4	3.3	.8
Pack time	.4	.2	.1		.2	.2	.1	.1	1.3	.3
Lost time	.5			.8	.3	.1	.3	.1	2.1	.5
Productive time (lb./hr.)	941	686	714	659	832	713	711	955		786
Total time	5.5	5.3	6.1	4.9	9.0	5.7	7.2	5.9	49.6	12.4
Number stops	99	140	138	135	168	166	156	173	1175	294
Total pounds	3480	2880	3640	2440	5740	3280	4340	4680	30480	7620
Time Per Stop	.06	.04	.04	.04	.05	.03	.05	.03		.04

Weekly Averages for Waste Collectors	Man 1	Man 2	Man 3	Man 4
Number stops	81	63	90	60
Time collecting	2.3	2.0	2.5	2.1
Clean up time	.1	.2	.2	.1

3. Entire Route

Primary totals of the information gained during the eight weeks study of backdoor collection for the east and west route are:

Entire Route Backdoor Collection	Weekly Average
Refuse	21,280 lbs.
Stops	777
Time Collecting Refuse	28.3 hr.

C. Curbside Collection

Base data was also compiled on the entire route during curbside collection. Normally Atlanta's refuse is collected at the backdoor, however, for purposes of this study, the results of backdoor pickup of normal refuse are to be compared to backdoor pickup of compacted refuse as well as a comparison of curbside collection of normal refuse to curbside collection of compacted refuse. Therefore, for a period of four weeks and eight collection periods, a study was made of curbside collection over the entire route. A summary of curbside collection of normal refuse prior to installation of the compactor using a compactor truck and two man crew is shown on Table XI. Forms used during this collection are found in the Appendix under Item F as well as definitions applicable to Table XI.

TABLE XI

ENTIRE ROUTE
CURBSIDE COLLECTION
BASE DATA 4 WEEKS SUMMARY OF 8 COLLECTION PERIODS

Equipment: 1 compactor truck
Crew: 1 waste collection driver, 2 waste collectors
Time is calculated in hours and tenths of an hour.

Collection Period	1	2	3	4	5	6	7	8	Total	Wk. Ave.
Total route time	3.3	3.3	3.3	2.7	3.8	2.7	3.1	2.7	24.9	6.2
Time collecting	1.5	1.9	1.7	1.1	2.0	1.1	1.5	1.2	12.0	3.0
Clean up time	.2	.1						.1	.4	.1
Wait time				.1	.1	.1	.1		.4	.1
Ride time	1.0	1.0	1.2	1.2	1.2	1.2	1.2	1.2	9.2	2.3
Pack time	.3	.3	.3	.2	.4	.2	.3	.2	2.2	.5
Lost time	.3		.1	.1	.1	.1		.1	.8	.2
Productive time (lb./hr.)	2896	2648	3751	3357	3696	3217	4770	2992		3434
Total time	3.3	3.3	3.3	2.7	3.8	2.7	3.1	2.7	24.9	6.2
Number stops	237	269	277	263	323	279	318	259	2225	556
Total pounds	7240	7680	10880	7720	11830	7400	12880	7180	72810	18202.5
Time Per Stop	.01	.01	.01	.01	.01	.01	.01	.01		.01

1. Segmented Data

The test route was reduced to 28 segments or blocks to obtain more specific data on the curbside collection. Such data will allow comparison on a segment by segment basis of curbside collection of normal refuse to curbside collection of compacted refuse. Item G in the Appendix identifies the segments by streets. The segmented base data of curbside collection of normal refuse is tabulated on Table XII.

Cost of curbside collection of normal refuse for the entire test route using the compactor truck and a two man walking crew is shown below:

TOTAL COST

Item	Per Hour	Per Day*	Per Week**
Truck	2.63	20.97	41.94
Labor	10.18	81.45	162.90
Two Waste Collector IIs			
Total	$12.81	$102.42	$204.84

*Based on one eight hour day.
**Based on two eight hour days.
***Waste Collector II is a walking crewman.

TABLE XII

SEGMENTED DATA OF ENTIRE ROUTE
CURBSIDE COLLECTION
BASE DATA 4 WEEKS SUMMARY OF 8 COLLECTION PERIODS

Segment	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Ave. no. cans/week	27	20	8	9	24	22	18	17	19	18	9	16	6	10
Ave. no. cans/week	24	13	8	3	17	13	23	15	10	10	13	10	3	13
Ave. no. bags/week	34	23	8	10	27	40	18	26	38	26	4	27	7	12
Ave. no. odd/parcels	5	11	2	2	6	15	7	5	5	5	2	4	2	3
Ave. coll. time	6:57	6:32	2:23	2:23	6:55	7:30	6:56	4:07	4:21	5:20	3:19	4:20	2:31	3:07
Ave. travel time	3:07	5:31	2:21	3:21	5:21	3:07	3:05	2:54	4:23	4:56	3:58	8:06	1:54	2:22
Ave. clean up time	1:01	1:31	:29	1:05	2:51	1:18	:08	:39	:35	1:28	:06	:32	-	:31
Ave. pack time	:31	1:20	:31	:21	:31	1:21	:29	:06	:57	:29	:03	:54	:26	:06
Ave. lost time	:11	-	-	:05	-	:14	:07	-	:11	1:01	-	1:07	-	:40

TABLE XII CONTINUED

SEGMENTED DATA OF ENTIRE ROUTE
CURBSIDE COLLECTION
BASE DATA 4 WEEKS SUMMARY OF 8 COLLECTION PERIODS

Segment	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Total	Avg. Per Segment
Ave. stops per week	9	23	42	22	22	10	29	9	80	4	7	20	1	28	529	19
Ave. no. cans/week	10	31	45	7	8	11	33	15	122	4	10	35	2	43	551	20
Ave. no. bags/week	8	6	33	28	32	16	22	3	34	1	.50	5	.25	14	502.75	18
Ave. no. odd/parcels	2	1	5	3	6	.75	4	.75	9	.25	-	1.75	-	4	111.50	4
Ave. coll. time	4:21	6:32	15:05	3:30	6:18	3:20	8:07	2:06	25:33	:31	1:55	6:55	1:15	8:31	2:41:07	6:15
Ave. travel time	4:08	4:57	9:05	9:19	6:20	2:30	4:20	2:07	11:20	:55	1:30	2:57	:27	5:24	1:59:45	4:28
Ave. clean up time	:03	:03	1:17	-	-	-	-	-	:38	-	-	-	-	:05	14:20	:52
Ave. pack time	:05	:31	1:05	:54	:55	:04	1:06	:31	3:06	:32	:14	:06	:07	1:06	18:27	1:07
Ave. lost time	:33	-	4:01	-	-	-	1:20	-	1:01	-	:27	:07	-	1:07	12:12	:43

D. Questionnaire I.

Once the collection of base data was completed, the Project Director began installation of the compactors in the homes of the residents. Approximately 380 compactors were installed and more units were later placed in service to satisfy resident mobility. At the same time the compactors were installed, a survey team member accompanied the Sanitation Services team in order to explain the operation of the unit and to complete the first questionnaire of the project.

1. Total Response

The first questionnaire (Item H Appendix) was very informative. Definitive data concerning the total route as well as specific information relating to household size is available. Most residents have had some college education and upper incomes are fairly evenly split at three levels. Practically all residents own their homes and most have two or more cars. This group should be very responsive to future questions involving compactor evaluation as well as evaluation of the type of collection service they are receiving. There were 382 responses to Questionnaire I. Questions and responses are as follows:

1. How many large outside cans do you have?

Cans	1	2	3	4	5	6
Households	3%	50%	30%	12%	3%	2%

2. How often are the cans filled?

Cans are filled	1 time/week	1½ time/week	2 time/week	3 time/week
Households 382	25%	6%	63%	6%

Normal collection in Atlanta is twice a week. Most residents fill their cans two times a week and have the number of cans necessary to accommodate refuse to the day of pickup without overflow.

3. Is collection adequate for the residents of the test route?

Normal collection service, that is two times a week, is adequate for practically all residents. Ten percent of the residents stated collection twice a week was not sufficient, however, of this number, five percent fill the cans they have twice a week suggesting they would like service three times a week rather than require service three times a week. Five percent would prefer service more often than twice a week.

4. Do you have a garbage disposal?

Yes 50% No 50%

5. Do you purchase frozen or canned goods?

Frozen 34% Canned 38% Equal of both 28%

6. Are magazines a part of the trash?

Yes 65% No 35%

7. Are newspapers a part of the trash?

Yes 63%   No 37%

8. What is the age of the head of the house?

20 years	5%
30 years	25%
40 years	31%
50 years	28%
60 and up	11%

9. What is the average educational level of the head of the house?

84% have had some college education.

10. What is the income of the residents?

$ 5-15,000	24%
15-25,000	32%
25-40,000	27%
40,000 up	17%

11. How many residents own their homes?

97% of the residents own their homes.

12. How many residents have more than one car?

1 car	14%
2 cars	62%
3 cars	24%

13. Do the residents have a maid?

Yes 58%   No 42%

In summary, most residents have two or three cans they fill once or twice a week. Collection at the backdoor twice a week is satisfactory. The residents purchase an equal number of canned and frozen goods and approximately 65% place newspapers and magazines in the trash even though the Parent-Teacher Association at local schools is involved in an active continuing paper recycling project. Approximately half the residents have a garbage grinder. The majority of the residents are between 30 and 50 years of age, in the upper income level, own homes, have two cars and have had some college education. About half the residents employ a maid.

2. Response Based on Household Size

Questionnaire I was divided into household size to obtain information relating directly to the number of residents per household. A summary of Questionnaire I by household count is as follows on Table XIII.

TABLE XIII

QUESTIONNAIRE I

Question	1 Resident 7 Households	2 Residents 93 Households	3 Residents 81 Households	4 Residents 113 Households
1. How many large outside cans do you have?	72% - 2 cans 14% - 3 cans 14% - 4 cans	3% - 1 can 63% - 2 cans 24% - 3 cans 9% - 4 cans 1% - 5 cans	1% - 1 can 56% - 2 cans 30% - 3 cans 6% - 4 cans 2% - 5 cans 5% - 6 cans	4% - 1 can 43% - 2 cans 36% - 3 cans 13% - 4 cans 4% - 5 cans
2. How often are these cans filled?	71% of the residents with 2 cans fill these cans once or twice a week. 29% of the residents with 3 or 4 cans fill them once a week.	This group has 2 or 3 cans they fill 1 or 2 times a week with the exception of 3 households. One household has only 1 can and no garbage disposal. Household 2 raises dogs with 10 dogs at all times and no garbage grinder. Household 3 has 52 parties each year. Collection service is adequate for this group with the exception of the 3 just mentioned	Most of this group has 2 or 3 cans they fill 1 or 2 times a week. 4 households could use collection service 3 times a week.	Most of this group has 2 or 3 cans that are filled 1 or 2 times a week. 10 households requested collection service 3 times a week.
3. Is collection at the backdoor adequate for this group?	yes	With the exception of 3.	Yes, all but 4 households.	Yes, all but 10 households.

TABLE XIII - CONTINUED
QUESTIONNAIRE I

Question	5 residents 62 Households	6-7 Residents 21 Households	8-9 Residents 6 Households
1. How many large outside cans do you have?	2% - 1 can 40% - 2 cans 37% - 3 cans 16% - 4 cans 2% - 5 cans 3% - 6 cans	10% - 1 can 38% - 2 cans 14% - 3 cans 28% - 4 cans 5% - 5 cans 5% - 6 cans	20% - 2 cans 20% - 3 cans 20% - 4 cans 40% - 6 cans
2. How often are these cans filled?	Most of the group has 2 or 3 cans that are filled 1 or 2 times each week with the exception of 5 households who fill their cans 3 times a week and would prefer collection 3 times a week.	90% of this group fill their cans 1 or 2 times a week. The remainder would prefer collection 3 times a week.	Collection is adequate for all but 1 household that would prefer collection 3 times a week. All cans are filled twice a week.
3. Is collection at the backdoor adequate for this group?	Yes except for 5 households.	10% would prefer collection 3 times a week.	Yes with the exception of 1 household.

TABLE XIII - CONTINUED
QUESTIONNAIRE I

Question	1 Resident 7 Households	2 Residents 93 Households	3 Residents 81 Households	4 Residents 113 Households
4. How many have a garbage grinder?	57%	40%	43%	48%
5. How many place newspapers and magazines in the trash?	Almost all	Almost all	Almost all	Slightly more than half.
6. Is the majority of refuse generated by this group paper?	Yes	Yes	Yes	Yes
7. What is the median age of this group?	50-60	50-60	30-60	30-60
8. Education?	Approximately 50% have had some college education.	81% have had some college education.	88% have had some college education.	The majority of this group has had some college education.
9. Income?	57% - $5-15,000 29% - $25-40,000 14% - $40,000 up	24% - $5-15,000 41% - $15-25,000 21% - $25-40,000 14% - $40,000 up	33% - $5-15,000 21% - $15-25,000 26% - $25-40,000 20% - $40,000 up	20% - $5-15,000 37% - $15-25,000 31% - $25-40,000 12% - $40,000 up

TABLE XIII - CONTINUED
QUESTIONNAIRE I

Question	5 Residents 62 Households	6-7 Residents 21 Households	8-9 Residents 6 Households
4. How many have a garbage grinder?	61%	90%	60%
5. How many place newspapers and magazines in the trash?	Approximately half of this group places newspapers and magazines in the trash.	Just about half place newspapers and magazines in the trash.	Most save newspapers for the schools and put magazines in the trash.
6. Is the majority of refuse generated by this group paper?	Yes	No, less than half.	Yes
7. What is the median age of this group?	30-50	40	30-40
8. Education?	Most of this group has had some college education.	Most of this group has had some college education.	All have had some college education.
9. Income?	16% - $5-15,000 31% - $15-25,000 34% - $25-40,000 19% - $40,000 up	20% - $5-15,000 20% - $15-25,000 15% - 25-40,000 45% - $40,000 up	25% - $5-15,000 25% - $15-25,000 50% - $25-40,000

STAGE 2.

All data to be collected prior to installation of the compactor was completed and the compactors were installed in the homes of the residents on the project route. The residents were given an opportunity to use the compactors for a few weeks to become adjusted to this method of handling trash and were provided with routine backdoor collection twice a week during the trial period.

The purpose of Stage 2 was to gather detailed information relating to every facet of refuse collection with a compactor in the home. Questionnaires were given to the residents to complete relating to the compactor and its performance. Specific data was obtained during backdoor collection using the satellite vehicle and walking crews for comparison with data of the same obtained prior to installation of the compactor. Data was also compiled on curbside collection using the rear loading compactor and open bed trucks. Disposal of compacted waste at the landfill and the incinerator was observed and data gathered on methods used.

During Stage 2 (one year) collection service was provided one day a week instead of the normal two days a week. The year was subdivided into quarterly phases. Each phase was designed to gather information concerning varying types of collection techniques, disposal methods and resident opinion of the compactor.

A. Phase I.

This phase dealt with three areas of information. (1) Specific time and motion demonstration data was taken on the East Liddell route after the installation of the compactor utilizing the satellite vehicle for backdoor collection. (2) Data was also compiled on the disposal of compacted waste at the landfill and (3) the second questionnaire of the study was completed by the residents.

1. East Liddell Route (Demonstration Data)

This route was described previously. See Figure 2, page 45. The same data forms used to obtain base data were also used to obtain demonstration data. (Appendix, Item C). The crew used during the collection of demo data consisted of the truck driver and two satellite vehicle drivers. Equipment consisted of a Loadmaster rear-loading 20 yard capacity truck with a two cubic yard hopper. Two satellite vehicles, International scouts, were also used. The Project Director used a wristwatch, stopwatch and odometer to measure time and distance. Demonstration data collected on the East Liddell route during 11 weeks and 11 collection periods is shown on Table XIV and applicable definitions are in Appendix C.

Cost of backdoor collection once a week after installation of the compactor on the East Liddell route using the compactor truck and two satellite vehicles is as follows:

TOTAL COST

Item	Per Hour	Per Day *	Per Week **
Truck	$ 2.63	$ 20.97	$ 20.97
2 Satellite vehicles	$ 1.64	$ 13.18	$ 13.18
2 Waste Collector III*** 1 Waste Collector Driver	$10.46	$ 83.65	$ 83.65
Total	$14.73	$117.80	$117.80

*Based on one eight hour day.

**Collection is once a week, one eight hour working day.

***Waste Collector III is a satellite vehicle driver.

Your attention is directed to basic cost tables in the Appendix, Item D.

TABLE XIV

EAST LIDDELL ROUTE
BACKDOOR COLLECTION
DEMONSTRATION DATA 11 WEEK SUMMARY OF 11 COLLECTION PERIODS

Equipment: 1 compactor truck, 2 satellite vehicles
Crew: 1 waste collection driver, 2 satellite vehicle drivers
Time is calculated in hours and tenths of an hour.

Collection Period	1	2	3	4	5	6
Total route time	4.0	4.0	3.6	4.3	3.9	4.2
Time collecting	7.2	7.2	6.5	7.8	7.0	7.5
Clean up time	.7	.6	.6	.6	.5	.6
Wait time	.1		.1		.1	.1
Lost time						
Break down time						
Productive time (lb./hr.)	1811	1858	1820	1782	1900	1763
Total time	8.0	7.9	7.2	8.5	7.6	8.2
Total stops	227	226	236	230	230	234
Total pounds	13,040	13,380	11,830	13,900	13,300	13,220
Time Per DU	.04	.03	.03	.04	.03	.04

Weekly Averages for Waste Collectors	Man 1	Man 2
Number stops	113.6	115.3
Time collecting	3.6	3.5
Clean up time	.4	.2
Wait time	.05	.05
Lost time		
Total time	4.05	3.75

TABLE XIV - CONTINUED

EAST LIDDELL ROUTE
BACKDOOR COLLECTION
DEMONSTRATION DATA 11 WEEKS SUMMARY OF 11 COLLECTION PERIODS

Collection Period	7	8	9	10	11	Total	Wk. Ave.
Total route time	3.8	3.6	3.7	4.3	3.7	43.1	3.9
Time collecting	6.9	6.7	6.7	8.2	6.8	78.5	7.1
Clean up time	.6	.6	.5	.6	.6	6.5	.6
Wait time	.1			.1	.1	.5	.05
Lost time		.1	.1	.1	.1	.6	.05
Break down time							
Productive time (lb./hr.)	2055	1961	1986	1482	1829		1842
Total time	7.7	7.4	7.3	9.0	7.5	86.3	7.8
Total stops	228	229	233	231	228	2532	230
Total pounds	14,180	13,140	13,304	12,155	12,440	143,889	13,081
Time Per DU	.03	.03	.03	.04	.03		.03

2. Landfill Disposal of Compacted Refuse

Primary objectives of the landfill test were to determine what problems, if any, exist in the landfilling of compacted refuse and whether or not efficient land use can be achieved with compacted refuse. All compacted refuse collected during this six month test was transported to test cells reserved at a local landfill convenient to the demonstration route. Figure 4 shows the location of the disposal sites in relation to the project route.

Two cell-type test units were excavated. The surveyor's plan of the cells is shown on Figure 5 and Figure 6 represents shape of test cells and layers of refuse and cover material. Test Cell No. 1 received compacted refuse from the test route. Test Cell No. 2 received normal residential refuse collected in a standard rear-loading compactor truck. In order to maintain similar refuse characteristics, the base material (Cell No. 2) was collected from the same proximity as the test route over the same time period.

Daily operation of the test cells was performed under normal sanitary landfill procedures. Major elements in this process were the proper placement of refuse, effective compaction and adequate cover. Refuse was dumped from the collection truck then spread and compacted by the crawler-tractor. The operator was instructed to make 20 compactor passes over each load of compacted and non-compacted refuse in order to maintain similar test conditions. The limited amount of compacted refuse available created a situation of abnormality in the test cells. Normally, daily cover is applied to very large amount of refuse, however, only two truckloads of compacted refuse were available daily. In order to apply adequate daily cover, the operator was forced to use an excess amount of cover dirt in proportion to refuse. In order to assure uniformity, Test Cell No. 2 (non-compacted refuse) was operated in the same manner as the compacted refuse cell.

An experienced operator was used throughout the test period. Daily activities of the test cells were recorded on a form provided by the operator. Data recorded each day of operation included the weight of refuse placed, amount of cover material and machine-man-hours worked in each cell. The form used is Item I, Appendix. An International Model 250 crawler-type tractor was used during the landfill test. The tractor has a weight of approximately 42,000 pounds. The tractor is equipped with a three cubic yard front loading bucket and grouser bars on the track.

During the test period, 199 tons of compacted refuse were placed in Cell No. 1 and 131 tons of normal refuse were placed in Cell No. 2. Observation of the landfilling characteristics revealed no discernible difference in the two test cells. The landfill operator was able to effectively spread and compact the test refuse without difficulty. The operator observed no difference in landfilling characteristics of compacted versus normal refuse. Blowing paper was not a problem in either cell.

Examination of the compacted refuse before compaction by the crawler-tractor showed most of the bags to be intact, although the majority were not sealed in any fashion. After the refuse was dumped, it was spread over the working face of the cell and compacted by the crawler. Examination of the refuse after compaction revealed no compactor bags left intact. The tractor grousers shredded the bags beyond recognition. A summary of landfill test data is shown on Table XV.

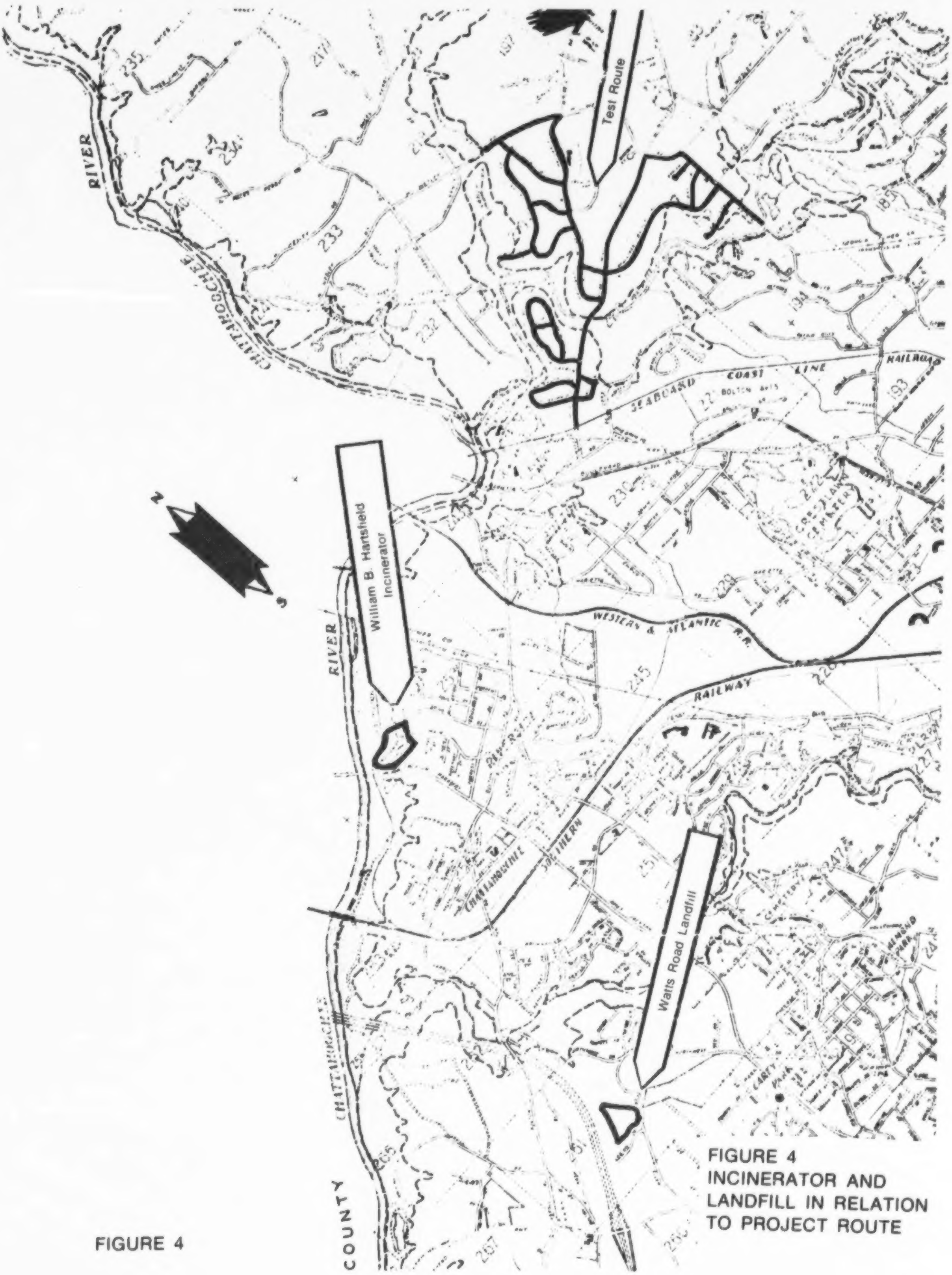

Test Route
William B. Hartsfield Incinerator
Watts Road Landfill
CHATTAHOOCHEE RIVER
RIVER
SEABOARD COAST LINE RAILROAD
BOLTON
CRESTLAWN CEMETERY
WESTERN & ATLANTIC R.R.
SOUTHERN RAILWAY
CHATTAHOOCHEE
COUNTY
N
S

FIGURE 4

FIGURE 4
INCINERATOR AND
LANDFILL IN RELATION
TO PROJECT ROUTE

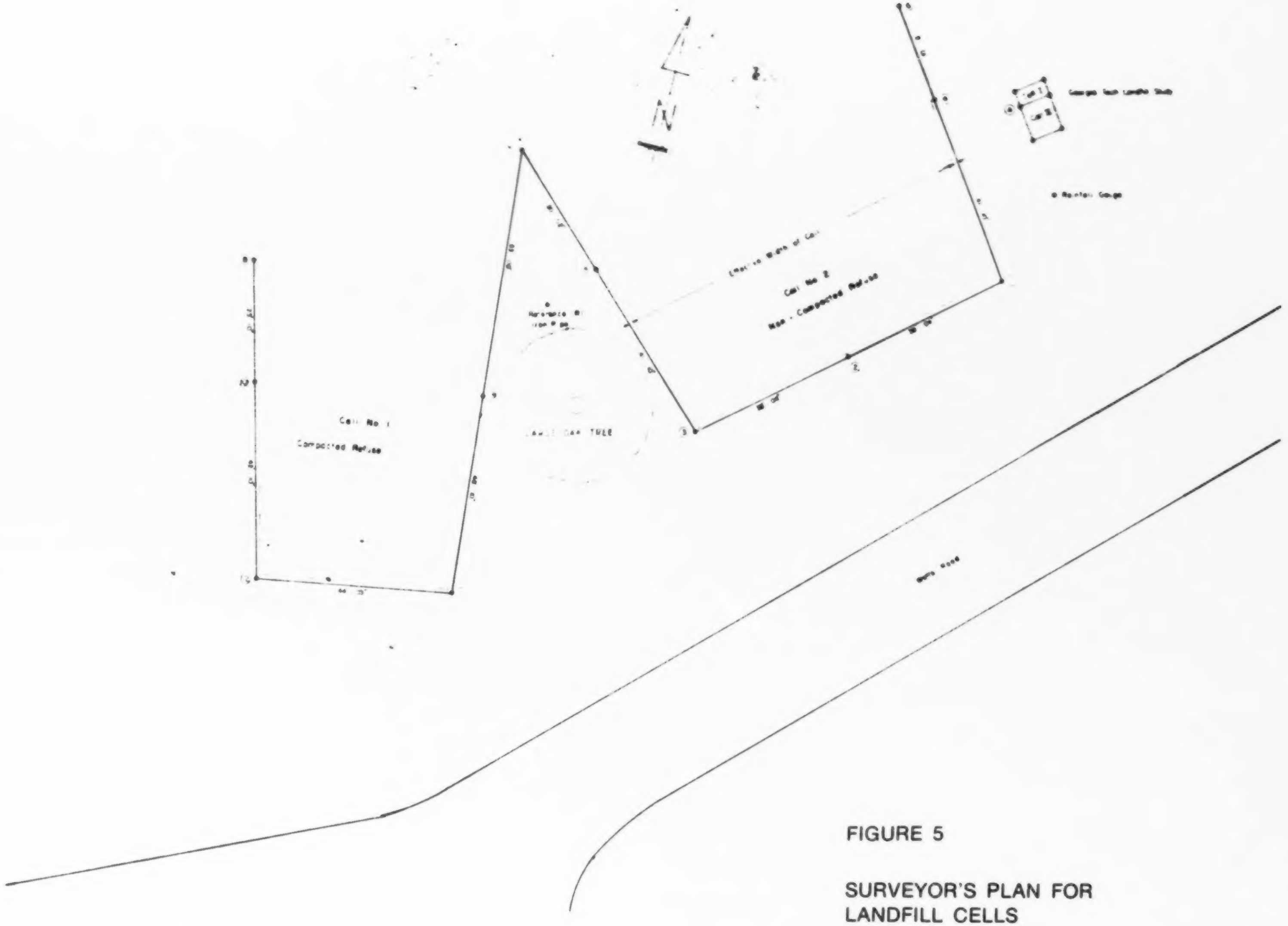
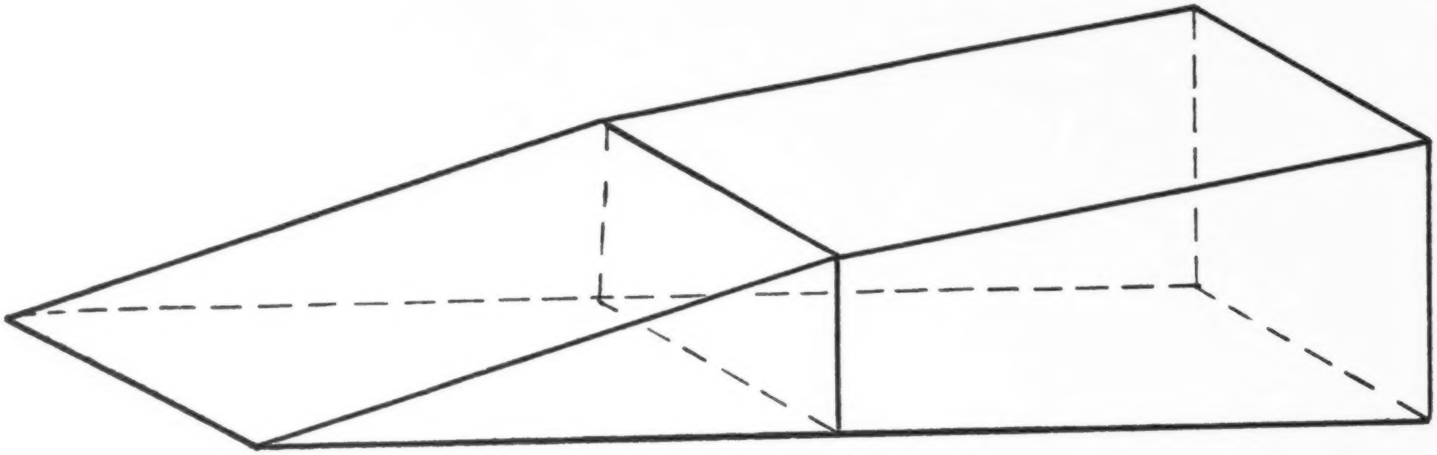
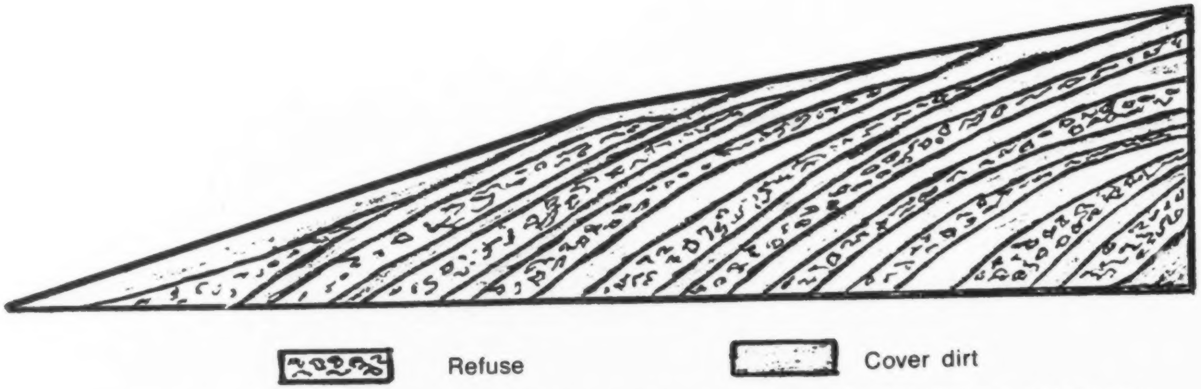

N
Effective Width of Cell
Cell No. 2
Non - Compacted Refuse
Rainfall Gauge
Cell No. 1
Compacted Refuse
LARGE OAK TREE

FIGURE 5

SURVEYOR'S PLAN FOR
LANDFILL CELLS



THIS GEOMETRIC FIGURE IDEALISTICALLY REPRESENTS THE SHAPE OF THE TEST CELLS.



THIS CROSS-SECTION REPRESENTS THE LAYERS OF REFUSE AND COVER MATERIAL.

FIGURE 6 SHAPE OF TEST CELLS

PHOTOGRAPH IV
LANDFILL CELL 1 100% COMPACTED REFUSE

PHOTOGRAPH V
COMPACTED REFUSE IN CELL

TABLE XV

LANDFILL TEST DATA

Item	Compacted Test Cell No. 1	Non-Compacted Test Cell No. 2
Pounds of refuse in place	398,790	262,300
Bucket cover material (3 cu. yd./bucket)	70	53
Pounds cover material	420,000	318,000
Volume of each cell (yd^3)	572.5	563.0
Landfill density* (final)	700 lbs./yd.^{3}	470 lbs./yd.^{3}
True density** (final)	1430 lbs./yd.^{3}	1030 lbs./yd.^{3}

*Landfill density = refuse weight/volume of cell.

**True density = refuse + cover weight/volume of cell.

Increases in both landfill and true densities were noted between the survey taken three months after the test began and the final survey. The test was designed to similate four months use of a landfill cell. Density increases are attributed to the compacting effect of additional refuse and cover added and also to the settling effect over time.

Cost of landfill disposal in Atlanta is based on a Special Services Division, Public Works Department, City of Atlanta, report on landfill disposal cost.

AVERAGE OPERATING AND MAINTENANCE COST EACH TRACTOR

Item	Cost Per Year	Cost Per Day
Fuel	$ 914.57	$ 4.30
Oil	61.72	.29
Grease	6.80	.03
Parts	5,155.03	24.26
Labor	2,118.24	9.97
Depreciation*	3,991.00	18.78**
Total	$12,247.76	$57.63

*Based on an estimated life of eight years.
**Based on 2,125 operating days for ten tractors.

Landfill Operator Costs

Average base cost per day	$ 35.32
Average base cost per day	$ 9,183.20
Total cost per day*	$ 41.48
Total cost per year*	$10,784.75

*Includes fringe benefits

Landfill Laborer Costs

Waste Collector I per week	$ 114.40
Waste collector I per year	$ 5,948.80
Total cost per week*	$ 134.85
Total cost per year*	$ 7,012.20

*Includes fringe benefits

Supervision and Administration

Total supervisory cost per year for 1 landfill	$4,229.17
Total administrative cost per year, 1 landfill	$ 399.00

TOTAL LANDFILL COST
6 LANDFILLS
CITY OF ATLANTA

	Total Cost 6 Landfills	1 Landfill Per Year	1 Landfill Per Day
Operating Cost** (10 tractors)	$ 82,563.60 ÷ 10 =	$ 8,256.36	$ 38.96
Depreciation Cost (10 tractors)	39,910.00 ÷ 10 =	$ 3,391.00	$ 16.00
Operators Cost* (9 operators)	97,062.75 ÷ 6 =	$16,177.13	$ 76.31
Laborers Cost* (4 laborers)	28,048.80 ÷ 6 =	$ 4,674.80	$ 22.05
Supervision Cost* (2 supervisors)	25,375.00 ÷ 6 =	$ 4,229.17	$ 19.95
Administrative Cost (1.3% ad. budget)	2,394.00 ÷ 6 =	$ 399.00	$ 1.88
Total		$37,727.46	$177.96

*Includes fringe benefits

**Based on 212 days, average no. days each year 10 tractors are in use.

Cost is further defined by the City of Atlanta Sanitation Department in terms of cost per load (exclusive of land cost). Total cost of operation of the city's six landfills was determined to be approximately $275,350 per year. During 1971 total revenue received from landfill operation was $12,200 yielding a net operation expense of $263,150. Based on a total of 170,052 loads, 1, 377,216 yards and 291,750 tons landfilled, the following is determined:

Cost per load received	$1.55
Cost per yard received	$0.19
Cost per ton landfilled	$0.94
Cost per ton, net*	$0.90

*Revenue received is subtracted from cost.

Analysis reveals landfills in the City of Atlanta dispose of solid waste at a cost of about $0.94 per ton, exclusive of land cost.

3. Questionnaire II.

This questionnaire was divided into household size in order to determine exactly what effect, if any, results from the use of the compactor in varying size households will have and to determine, if possible, the size household most likely to achieve optimum use of the compactor. Questionnaire II is Item J in the Appendix. Advantages and disadvantages of the unit to varying size households, if any exist, would also become evident. A tabulated summary of this questionnaire is shown on Table XVI.

TABLE XVI
QUESTIONNAIRE II

	Household by Sizes							Total
	1	2	3	4	5	6-7	8-9	
Total responses	7	87	86	91	80	17	4	372
Number households with at least 1 pet	3	43	42	75	51	13	3	230
Complained of curbside pickup	-	12	14	17	12	3	2	60
Complained of collection once a week	-	-	-	2	-	-	-	2
								Average
90-100% of trash placed in compactor (1)	71%	50%	50%	50%	32%	24%	50%	46%
80-90% of trash placed in compactor	-	10%	15%	15%	25%	-	-	9%
70-80% of trash placed in compactor	-	24%	20%	20%	33%	60%	50%	30%
25-70% of trash placed in compactor	29%	16%	15%	15%	10%	16%		15%
	100%	100%	100%	100%	100%	100%	100%	100%
Compactor located in kitchen (2)	71%	65%	60%	60%	65%	60%	75%	65%
Would prefer another location	14%	30%	33%	40%	35%	40%	25%	31%
How convenient do you consider the unit?								
Excellent	86%	50%	45%	55%	54%	30%	100%	60%
Good	14%	30%	35%	30%	30%	50%	-	27%
Fair	-	15%	15%	10%	14%	15%	-	10%
Poor	-	5%	5%	5%	2%	5%	-	3%
	100%	100%	100%	100%	100%	100%	100%	100%
Do you have a garbage disposal? Yes (3)	57%	65%	50%	50%	70%	94%	50%	62%
Do you use your garbage disposal as you previously have?	57%	56%	40%	40%	62%	88%	50%	56%

TABLE XVI
QUESTIONNAIRE II CONTINUED

	Household by Sizes							Average
	1	2	3	4	5	6-7	8-9	
Do not feel the unit is noisy (4)	71%	85%	85%	80%	75%	90%	100%	83%
Feel unit is too noisy	29%	15%	15%	20%	25%	10%	-	17%
Have experienced some problem with odor	-	30%	50%	50%	40%	40%	50%	36%
Do not find unit difficult to clean	100%	85%	85%	80%	75%	70%	75%	81%
How do you place trash in compactor?								
Loosely	57%	45%	40%	50%	32%	40%	50%	45%
In bags	43%	35%	40%	30%	20%	10%	25%	29%
In bags and loosely	-	20%	20%	20%	48%	50%	25%	26%
	100%	100%	100%	100%	100%	100%	100%	100%
Store trash in receptacle	57%	75%	85%	75%	77%	84%	75%	75%
How often is the bag changed? (5)								
1-3 days	-	4%	1%	5%	1%	35%	75%	17%
3-7 days	85%	88%	65%	60%	98%	57%	25%	69%
7-10 days	15%	-	34%	30%	-	-	-	11%
10-14 days	-	8%	-	5%	1%	8%	-	3%
	100%	100%	100%	100%	100%	100%	100%	100%
Who removes the bag? (6)								
Man	50%	65%	60%	60%	50%	60%	Majority of time	
Who replaces the bag?								
Woman	50%	65%	60%	80%	Majority of time	78%	Majority of time	

TABLE XVI
QUESTIONNAIRE II CONTINUED

		Household by Sizes							Average
		1	2	3	4	5	6-7	8-9	
Is once a week collection adequate?	(7)								
Yes		100%	95%	95%	85%	85%	60%	100%	89%
No		-	5%	5%	15%	15%	40%	-	11%
		100%	100%	100%	100%	100%	100%	100%	100%
Maximum number of days household can go between collections -									
1 - 7 days		86%	78%	76%	95%	70%	81%	100%	84%
8 - 10 days		14%	12%	3%	-	15%	6%	-	8%
10 - 14 days		-	-	17%	5%	-	-	-	3%
Over 14 days		-	10%	-	-	15%	-	-	3%
No response		-	-	4%	-	-	13%	-	2%
		100%	100%	100%	100%	100%	100%	100%	100%
Has service been required?									
Yes		14%	1%	20%	16%	21%	29%	-	14%
Reduction in volume experienced	(8)								
By one-half or less		86%	70%	85%	86%	92%	94%	75%	84%
No reduction		14%	5%	10%	-	-	-	-	4%
Same		-	15%	-	-	-	-	-	6%
No response		-	10%	5%	14%	8%	6%	-	6%
		100%	100%	100%	100%	100%	100%	100%	100%

General Comments refer back to the preceding numbers:

(1) Items not placed in the compactor include: aerosol cans, coat hangers, cardboard boxes, wood scraps, broken toys, large plastic containers, disposable diapers, light bulbs, yard clippings, newspapers and magazines.

TABLE XVI

QUESTIONNAIRE II CONTINUED

(2) Relocation was not possible. The question was asked to determine whether or not residents felt location of the compactor of any importance. They do. Many who have the compactor in the kitchen would like it better "under the counter", "nearer the sink" or moved to "the other side of the kitchen". The kitchen was the most desirable location.

(3) Some used the compactor in preference to their garbage disposal for two reasons: 1. Do not care to sort trash. 2. Compactor relieves the burden on the septic tank.

(4) Odor is the major complaint about the compactor in this questionnaire with 36% complaining of odor problems.

(5) The bag is removed because it is full or as full as the resident wants it to be. It is also removed because it is garbage collection day.

(6) This is generally true for the entire route. Women state the bag is too heavy to lift.

(7) A few did not answer this question. The small percentage for whom once a week collection was not adequate felt they simply had more trash than they could store or they did not care for garbage around the house seven days.

(8) This question did not seem to be understood by a small proportion of the residents. They overlooked the word "volume" and stated "trash" was same as always. A few did not answer the question.

B. Phase II.

In this particular phase of the demonstration, extensive data was compiled on the curbside method of collection of compacted refuse one time a week on the entire test route. During this phase the landfill was used for disposal of refuse and this data was included with information pertinent to the landfill in Phase I. Therefore, Phase II will deal primarily with two areas, data obtained from curbside collection and Questionnaire III.

1. Entire Route (Demonstration Data)

The entire route was serviced once a week with curbside collection after the compactors were installed to obtain demonstration data for later comparison with the base data obtained during curbside collection prior to installation of the compactors. A compactor truck and two man crew was used during the 12 weeks of curbside collection. A summary of curbside collection of compacted refuse is shown on Table XVII.

The test route during this phase was also reduced to 28 segments to obtain demonstration data necessary for comparison with base data of the same segments obtained prior to compactor installation. The segments are identified in Item G of the Appendix. Demonstration data of street segments during curbside collection of refuse after the compactors were placed on the route is tabulated on Table XVIII.

Cost of curbside collection of "compacted" refuse for the entire test route using the compactor truck and a two man crew is similar to that shown for the base data cost of such collection except, curbside collection of normal refuse required collection twice a week and curbside collection of compacted refuse required collection once a week. Total cost is shown below:

Total Cost

Item	Per Hour	Per Day*	Per Week**
Truck	$ 2.63	$ 20.97	$ 20.97
Waste Collection Driver	3.68	29.45	29.45
2 Waste Collectors II***	6.50	52.00	52.00
Total	$12.81	$102.42	$102.42

*Based on an eight hour day.
**Collection is one time a week, one eight hour day.
***Waste Collector II is a walking crewman.

TABLE XVII

ENTIRE ROUTE
CURBSIDE COLLECTION OF COMPACTED REFUSE
DEMONSTRATION DATA 12 WEEKS SUMMARY OF 12 COLLECTION PERIODS

Equipment: 1 compactor truck
Crew: 1 waste collection driver, 2 waste collectors
Time is calculated in hours and tenths of an hour.

Collection Period	1	2	3	4	5	6
Total route time	3.8	4.2	3.7	3.9	3.6	4.0
Time collecting	1.7	2.0	1.7	1.5	1.9	1.7
Clean up time	.1	.2	.3	.2	.1	.3
Ride time	1.4	1.3	1.3	1.3	1.3	1.4
Pack time	.4	.4	.3	.4	.2	.3
Lost time	.2	.2	.1	.6	.1	.3
Productive time (lb./hr.)	6290	5709	6160	7779	6988	5729
Total time	3.8	4.2	3.7	3.9	3.6	4.0
Total stops	312	336	331	327	341	337
Total pounds	19.500	18,840	18,480	21,780	22,360	17,760
Time Per Stop	.01	.01	.01	.01	.01	.01

*Applicable definitions are in Appendix F.

TABLE XVII - CONTINUED

ENTIRE ROUTE
CURBSIDE COLLECTION OF COMPACTED REFUSE
DEMONSTRATION DATA 12 WEEKS SUMMARY OF 12 COLLECTION PERIODS

Collection Period	7	8	9	10	11	12	Total	Wk. Ave.
Total route time	3.2	4.1	4.3	3.3	3.6	3.6	45.3	3.8
Time collecting	1.4	1.8	2.0	1.5	1.5	1.6	20.3	1.7
Clean up time	.3	.4	.3	.1	.3	.2	2.8	.2
Ride time	1.2	1.4	1.5	1.3	1.3	1.5	16.2	1.4
Pack time	.3	.4	.4	.3	.3	.3	4.0	.3
Lost time	.1	.1	.1		.1		1.9	.2
Productive time (lb./hr.)	7008	6600	5731	6221	5293	5071		6077
Total time	3.2	4.1	4.3	3.3	3.6	3.6	45.3	3.8
Total stops	335	336	330	307	326	329	3947	329
Total pounds	18,220	21,120	20,060	17,420	14,820	15,720	226,080	18,840
Time Per Stop	.01	.01	.01	.01	.01	.01		.01

TABLE XVIII

SEGMENTED DATA OF ENTIRE ROUTE
CURBSIDE COLLECTION
DEMONSTRATION DATA 12 WEEKS SUMMARY OF 12 COLLECTION PERIODS

Segment	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Stops/week	18	5	3	1	15	15	13	15	11	11	7	15	3	5
Cans/week	14	6	3	1	15	13	20	20	23	14	14	16	1	6
Bags/week	16	2	2	.8	11	14	6	14	7	8	3	10	4	3
Odds/week	20	5	2	.5	6	19	11	19	13	13	4	6	3	3
Collection time	5:15	1:53	:53	:14	4:19	5:50	4:39	6:37	3:51	3:58	1:33	4:22	1:10	1:49
Travel time	3:17	1:56	1:01	:25	3:41	2:43	2:36	2:22	3:05	3:07	2:29	3:07	1:09	1:25
Clean-up	1:41	:17	:08	-	:03	2:25	:37	:39	:46	:41	:02	:58	:26	:08
Pack time	:59	:22	:05	:03	:40	1:13	1:02	1:00	:54	:34	:15	:57	:10	:23
Lost time	:16	:03	:25	-	:07	:15	:04	:05	:14	:10	:09	:20	-	-

See Glossary and Appendix F for definitions.

TABLE XVIII - CONTINUED

SEGMENTED DATA OF ENTIRE ROUTE
CURBSIDE COLLECTION
DEMONSTRATION DATA 12 WEEKS SUMMARY OF 12 COLLECTION PERIODS

Segment	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Total	Avg. per Seg.
Ave. stops per week	7	12	21	11	9	7	18	4	43	2	2	10	2	13	298	11
Ave. no. cans/week	5	17	24	6	8	6	24	6	50	.2	3	12	2	20	349.2	12.5
Ave. no. bags/week	6	3	13	10	8	5	8	4	22	2	1	6	.25	6	195.05	7
Ave. no. odd/parcels	3	4	11	11	8	5	9	2	18	.33	.8	4	.75	7	208.38	7
Ave. coll. time	1:43	3:53	7:20	2:12	2:21	1:46	5:57	1:22	11:43	:13	:38	2:51	:31	4:30	1 33:23	3:20
Ave. travel time	2:52	2:58	5:13	3:41	3:18	1:31	3:01	1.46	6.03	:30	:33	1:55	:27	2:28	1:08:39	2:27
Ave. clean up time	:07	-	1:06	:22	:22	:05	:43	:01	1:52	-	:04	:02	:02	:11	13:53	:29
Ave. pack time	:44	1:06	1:38	:52	:30	:19	:47	:18	1:47	:09	:09	:33	:03	:49	18:21	:39
Ave. lost time	:23	:07	:45	:01	-	:02	:30	:06	:40	-	-	:09	-	:21	5:12	:11

2. Questionnaire III.

It was soon discovered that location was an important consideration concerning the compactor. Some residents refused to participate in the project because there was no place to put the unit in their homes. Actual use and satisfaction with the compactor would no doubt largely depend on where the unit was located in the home. Therefore, Questionnaire III was very concerned with location. Questions were also concerned with resident satisfaction or dissatisfaction with curbside and backdoor collection. Questionnaire III is Item K in the Appendix. A summary of this questionnaire is as follows:

QUESTIONNAIRE III

1. Now that you have been using the compactor for some time, how would you rate your satisfaction with the unit?

Completely satisfied	39%
Satisfied	47%
Somewhat dissatisfied	9%
Completely dissatisfied	--
Not using the unit	4%
No response	1%

If not satisfied with the unit, why is that?

Weight	1%
Odor	3%
Too much trouble or inconvenient	3%
Poor service from manufacturer	1%
Miscellaneous	2%

- Drawer difficult to open
- Curbside collection
- Unit too small
- Not designed for wet garbage
- Not safe for small children
- Undesirable location
- Only one person in household

2. A. Where in your home do you have the compactor?

Kitchen	62%
Room adjacent the kitchen (pantry, breakfast room)	13%
Utility room	13%
Carport or garage	4%
Basement	4%
Back porch	1%
Elsewhere (closets, etc.)	2%
No response	1%

2. B. Because these homes were constructed prior to the introduction of the compactor to the market, most homes do not have adequate space for the compactor in the kitchen, therefore, many residents placed it in "make do" locations.

C\. Where would be the best location for you?

Kitchen related areas:	
near sink	51%
near sink under counter	6%
near stove	5%
by dishwasher	2%
near sink and stove	2%
kitchen corner	2%
near sink, stove & under counter	1%
7 feet from sink	1%
near refrigerator	1%
kitchen	1%
TOTAL	72%
Miscellaneous	
garage	
breakfast room	
pantry	
near table	
laundry room	
miles & miles away	
carport	
utility room	
outside	
near backdoor	
TOTAL	4%
No response	24%

2. D. Why would it be best in that location?

36% of the residents did not respond to this question. 17% of the residents chose the given location because it was convenient to where most of the garbage and trash generated. 16% of the residents stated it was convenient and 7% of the residents do most of their work there. Other reasons stated were: only location available, out of the way, centrally located, no odor, anywhere in the kitchen is ok, ideal location and it keeps garbage and trash away from food preparation.

E. Has the compactor always been located where it is now?

Yes 90% No 9% No response 1%

Original Location	New Location	Reason for Move
kitchen	kitchen	more convenient location
another room	kitchen	more convenient location
kitchen	under carport	kitchen too small
by refrigerator	by dishwasher	more convenient location
near stove	breakfast room	not enough space
across kitchen	near stove	saves space
kitchen	kitchen	remodeling
kitchen	dining room	in the way
kitchen	kitchen	convenience and space
near refrigerator	near stove	more functional
kitchen	kitchen	needed space for table
breakfast area	kitchen	needed space for table
by refrigerator	near sink	convenience
dinette	kitchen	remodeling
laundry room	pantry	too messy
under bar	near sink	needed space
kitchen	kitchen	to make room
kitchen	carport	odor
kitchen	utility room	needed space
kitchen	kitchen	needed space
basement	kitchen	no good in basement
living room	kitchen	ha!
carport	pantry	convenience
kitchen	garage	odor
breakfast nook	utility room	in the way
kitchen	kitchen	in the way
kitchen	kitchen	remodeled
breakfast room	kitchen	convenient

3. A. Was curbside collection better overall

before installation of the compactor	5%
after installation of the compactor	63%
same	12%
no response	20%

B. Was backdoor collection better overall

before installation of the compactor	10%
after installation of the compactor	63%
same	15%
no response	12%

4. Do you normally operate the compactor....

Each time an item is added	19%
Usually just when larger items are added	44%
Each time the container gets full	24%
Once a day	6%
Other	5%
No response	2%

5. Do you use the key to lock the compactor?

Yes 10% No 87% No response 3%

What percent of the refuse in your home do you put in the compactor?

52% of the residents place 90-100% refuse in the compactor
26% place 70-89% refuse in the compactor
10% place 30-69% refuse in the compactor
4% place 15-29% refuse in the compactor
1% place 1-14% refuse in the compactor
7% no response

6. What percent of the garbage in your home do you put in the compactor?

52% of the residents place 90-100% garbage in the compactor
11% place 70-89% garbage in the compactor
7% place 30-69% garbage in the compactor
4% place 15-29% garbage in the compactor
13% place 1-14% garbage in the compactor
8% place none
5% no response

7. Have you encountered odors from the compactor?

Yes 63% No 35% No response 2%

Which of the following best describes the frequency of odor?

Only once or twice	34%
During hot weather only	6%
Once a month or so	16%
Every week	12%
Daily or almost daily	4%
No response	28%

When you have odors, do they appear to be caused by specific items which have been put into the compactor?

Yes 41% No 27% No response 32%

If yes, what items? Food, specifically: Meat and fruit. Chicken and fish are strongest offenders. Meat wrappings are also considered to be a cause.

8. Have you had an insect or bug problem in connection with the compactor?

Yes 7% No 89% No response 4%

Which of the following describes the frequency of the problem?

Only once or twice	19 responses
During hot weather only	8
Once a month or so	5
Every week	-
Daily or almost daily	2
No response	-

Obviously, some of those who answered no to the problem answered the frequency of the problem section of this question.

Specifically, what type of bug or insect was present?

Fruit flies, ants, roaches, tiny insects, maggots and a mouse (also listed even though it is not considered to be bug or insect.)

When this happened did it appear to be caused by specific items which you put in the compactor?

Yes, food. Meat, chicken and corn.

9. A. Is the deodorant spray mechanism operating correctly in your compactor?

Yes 81% No 11% No response 8%

B How long ago did you replace the deodorant spray can?

Every 1-2 weeks	10%
Every 3-5 weeks	23%
Every 6-8 weeks	21%
Every 10-15 weeks	10%
Every 16-24 weeks	2%
Never replaced can	15%
Many months	2%
Used 2 cans	2%
Once	1%
Weeks ago •	3%
No response	10%

C. Does the spray have an objectionable odor?

Yes 7% No 89% No response 4%

10. A. How would you rate the compactor drawer?

Easy to operate	77%
Difficult	15%
Not easy, not hard	4%
Varies	1%
No response	3%

B. If difficult, is it so difficult as to restrict your use of the compactor?

Yes 5% No 14%

11. A. How often do you change bags in the compactor?

Every		4-5 days	7%
1-2 days	1%	5 days	8%
2 days	3%	5-6 days	5%
2-3 days	4%	6 days	11%
3 days	7%	6-7 days	2%
3 1/2 days	1%	7 days	23%
3-4 days	8%	7-10 days	1%
3-7 days	1%	10 days	1%
4 days	8%	14 days	1%

Miscellaneous answers by individuals - 8%
Comment: Collection once a week encourages the homeowner to change the bag in time for this collection. Also, the resident did not have to pay for the bags and it is reasonable to assume he would use the bags for a longer period of time because of cost and when collection resumes twice a week the resident is not pressured to have all his refuse out for collection.

65% of the residents change bags every 4-7 days and 17% change bags every three days.

B. Have there been problems or difficulties removing the bag from the compactor?

Yes 34% No 64% No response 2%

If yes, what is that? Heavy (71), breaking, leaking or tearing open (4), too full or tight fit (16), drawer problems (4), location problem (1), side sticks (5), hard to open (1), and too hard (2).

C. Have there been any problems or difficulties putting a new bag into the compactor?

Yes 8% No 89% No response 3%

If yes, what is it? Bags should be prefolded.

D. Have you encountered any difficulties or problems with tearing or ripping of the bags?

Yes 28%	No 69%	No response 3%

E. After the full bag is removed from the compactor, how is it secured?

Turn flaps down	63%
Folded and stapled	3%
Flaps down and sealed with tape	19%
Placed in a garbage can	6%
None	1%
Plastic bag tied with wire tape	1%
Tied with twine	2%
No response	4%

F. Please describe any other problems or difficulties you have experienced with the bags.

181 no response, 71 no problems, 12 tearing, 11 heavy, 88 soggy and breaking, 7 dogs, 5 won't fit in cans, 1 sides tear, 1 inferior insulation.
Percentages are not given because some residents found more than one problem with the bags.

12. Have you required service on your compactor since the last questionnaire?

Yes 22%	No 66%	No response 12%

Note: Some confusion existed on the part of the respondent as to whether they had required service during the course of the project and some could not remember exactly when the service was received.

Most persistent service problems were: drawer would not close properly, unit would run continually, replaced switches and latches and unit would not stop compressing.

In summary, the best location for the compactor is in the kitchen, ideally under the counter beside the sink. Eighty six percent of the residents are satisfied with the compactor and more than half feel curbside and backdoor collection was better with a compactor in the home.

Approximately half the residents have had odor emitting from the compactor at least once or twice and food items as well as meat wrappings are definitely the culprits. Very few have had any problem with bugs in or around the compactor.

The majority of residents find the drawer easy to operate, do not compact every time an item is placed in the unit and do not use the key.

Only 34% have had problems removing the filled bag from the unit and the majority do not have any problems replacing a new bag. More than half the residents remove the bag every four to seven days.

C. Phase III.

Demonstration data gathered during this phase of the study is to be used in comparative analysis with data obtained during the base data study of backdoor collection on the West Maddox route. During this period, the compacted refuse is taken to the incinerator for processing to determine if compacted material incinerates adequately in a rotary kiln incinerator. It is also necessary to know what changes, if any, are required to incinerate compacted material adequately and whether or not the changes affect efficiency and cost per ton of refuse consumption. In Phase III another questionnaire is analyzed to gain deeper insight as to use of the compactor in the home by residents on the project route.

1. West Maddox Route (Demonstration Data)

Equipment used to serve this route during the 12 week collection period consisted of a driver and four man walking crew. Equipment used consisted of a 20 cubic yard rear loading compactor truck. A summary of backdoor collection demonstration data on the West Maddox route for a period of twelve weeks and twelve collection periods is shown on Table XIX. Data terms and appropriate definitions are in Appendix E.

Cost of backdoor collection once a week after installation of the compactor on the West Maddox route using the compactor truck and four man crew is as follows:

TOTAL COST

Item	Per Hour	Per Day*	Per Week**
Truck	$2.63	$20.97	$20.97
Waste Collector Driver	3.68	29.45	29.45
Waste Collector II***	3.25	26.00	26.00
Waste Collector II	3.25	26.00	26.00
Waste Collector II	3.25	26.00	26.00
Waste Collector II	3.25	26.00	26.00
Total	$19.31	$154.42	$154.42

*Based on an eight hour day.
**Collection is once a week, one eight hour day.
***Waste Collector II is a walking crewman.
Cost tables are in Appendix D.

TABLE XIX

WEST MADDOX ROUTE
BACKDOOR COLLECTION
DEMONSTRATION DATA 12 WEEKS SUMMARY OF 12 COLLECTION PERIODS

Equipment: 1 compactor truck
Crew: 1 waste collection driver, 2 waste collectors
Time is measured in hours and tenths of an hour.

Collection Period	1	2	3	4	5	6
Total route time	1.5	1.4	2.0	1.2	1.1	1.2
Time collecting	4.7	4.3	4.0	4.4	4.9	3.6
Clean up time	.4	.4	.3	.4	.3	.4
Wait time	.6	.4	.3	.4	.2	.3
Ride time	.5	.5	.4	.3	.4	.5
Pack time	.3	.2	.2	.2	.1	.1
Lost time			.1	.1		
Productive time (lb./hr.)	1577	1671	1864	1371	1460	2146
Total time	6.5	5.7	5.3	5.6	5.9	4.7
Total stops	137.5	124.5	127	134	138	133
Total pounds	8200	8020	8200	7680	7740	8800
Time Per Stop	.05	.05	.04	.04	.04	.04

Weekly Averages for Waste Collectors	Man 1	Man 2
Number stops	37	32
Time collecting	1.0	1.0
Clean up time	.09	.08

TABLE XIX - CONTINUED

WEST MADDOX ROUTE
BACKDOOR COLLECTION
DEMONSTRATION DATA 12 WEEKS SUMMARY OF 12 COLLECTION PERIODS

Collection Period	7	8	9	10	11	12	Total	Wk. Ave.
Total route time	1.0	1.2	1.2	1.2	1.2	1.3	15.5	1.3
Time collecting	3.6	3.5	3.8	3.8	3.7	3.7	48.0	4.0
Clean up time	.1	.2	.4	.4	.3	.4	4.0	.3
Wait time	.3	.3	.2	.2	.3	.3	3.8	.3
Ride time	.4	.5	.4	.5	.4	.5	5.3	.4
Pack time	.1	.1	.2	.1	.1	.1	1.8	.2
Lost time	.1						.3	.02
Productive time (lb./hr.)	1970	2375	1876	1898	2000	2048		1872
Total time	4.7	4.6	4.8	4.8	4.7	4.9	62.2	5.2
Number stops	125	128	130.5	130	133	133	1573.5	131
Total pounds	7880	9500	7880	8160	8200	8600	98,860	8238
Time Per Stop	.04	.04	.05	.04	.04	.04		.04

Weekly Averages for Waste Collectors	Man 3	Man 4
Number stops	32	30
Time collecting	1.0	1.0
Clean up time	.1	.05

2. Incineration of Compacted Refuse

The primary objective of the incineration test was to determine what problems, if any, were evidenced during incineration of compacted refuse. All compacted refuse was taken to the Hartsfield Incineration Plant. (See Figure 4 for location of the incineration site in relationship to the test route on page 67.)

The plant was first placed into operation in April of 1963. It has three rotary kiln units which have a designed capacity of 250 tons/kiln/24 hour. Inclined reciprocating grates are used in the drying and ignition chambers. The ignition chamber is sometimes referred to as the "fire box". Further combustion is achieved in the kiln and mixing chamber. The combustion products from each furnace pass through separate water scrubbers and are discharged into the atmosphere through a common stack. The residue drops from the kiln into the quench tank where a drag conveyor removes the residue and discharges it into a residue truck for removal to a disposal site. Waste water from the scrubbers and quench tank flows through a grit chamber prior to its final disposal in a watercourse. Note Figures 7 and 8 for diagrams of the Hartsfield Incineration Plant.

Kiln No. 3 was used during all tests. This kiln is identical to the other two with the exception of age and kiln No. 3 is equipped with a "cyclone" dust collector. Although the dust collector had no direct effect on the tests at hand, it provided more valid results because it tended to make the unit maintain a more uniform temperature over time. This unit is equipped with four thermocouples. Temperatures were monitored during each test with primary attention directed to temperatures in the ignition grates and kiln.

All test refuse was weighed at the incinerator scales before it was placed in the storage pit. A dumping stall was reserved to house the test refuse until the test run and two piles of refuse were kept for the two test runs. One test stock pile contained 100 percent non-compacted refuse for the control base test. The refuse was collected from the same proximity as the test route and at the same time as the compacted refuse to assure uniformity in refuse characteristics and moisture content. The second pile of refuse was compacted refuse or the proper portion of compacted and uncompacted mix.

PHOTO VI
REFUSE PIT AT INCINERATOR

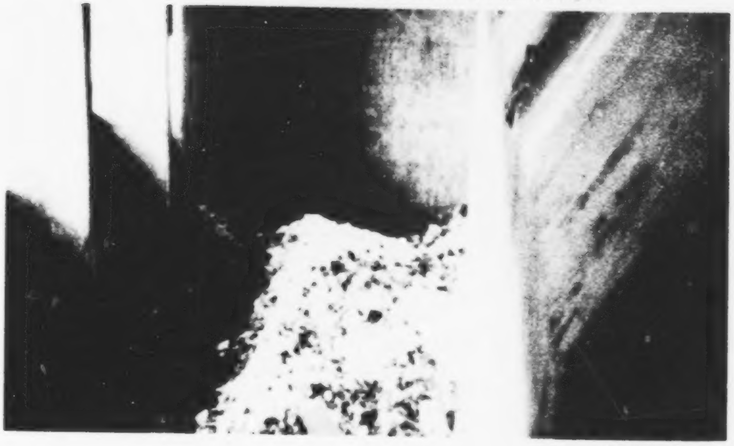


PHOTO VII
REFUSE STORAGE PIT

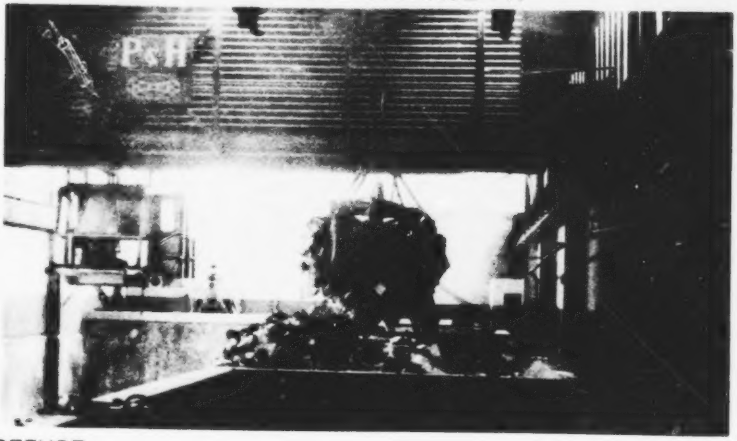


PHOTO VIII
CHARGING REFUSE
IN INCINERATOR

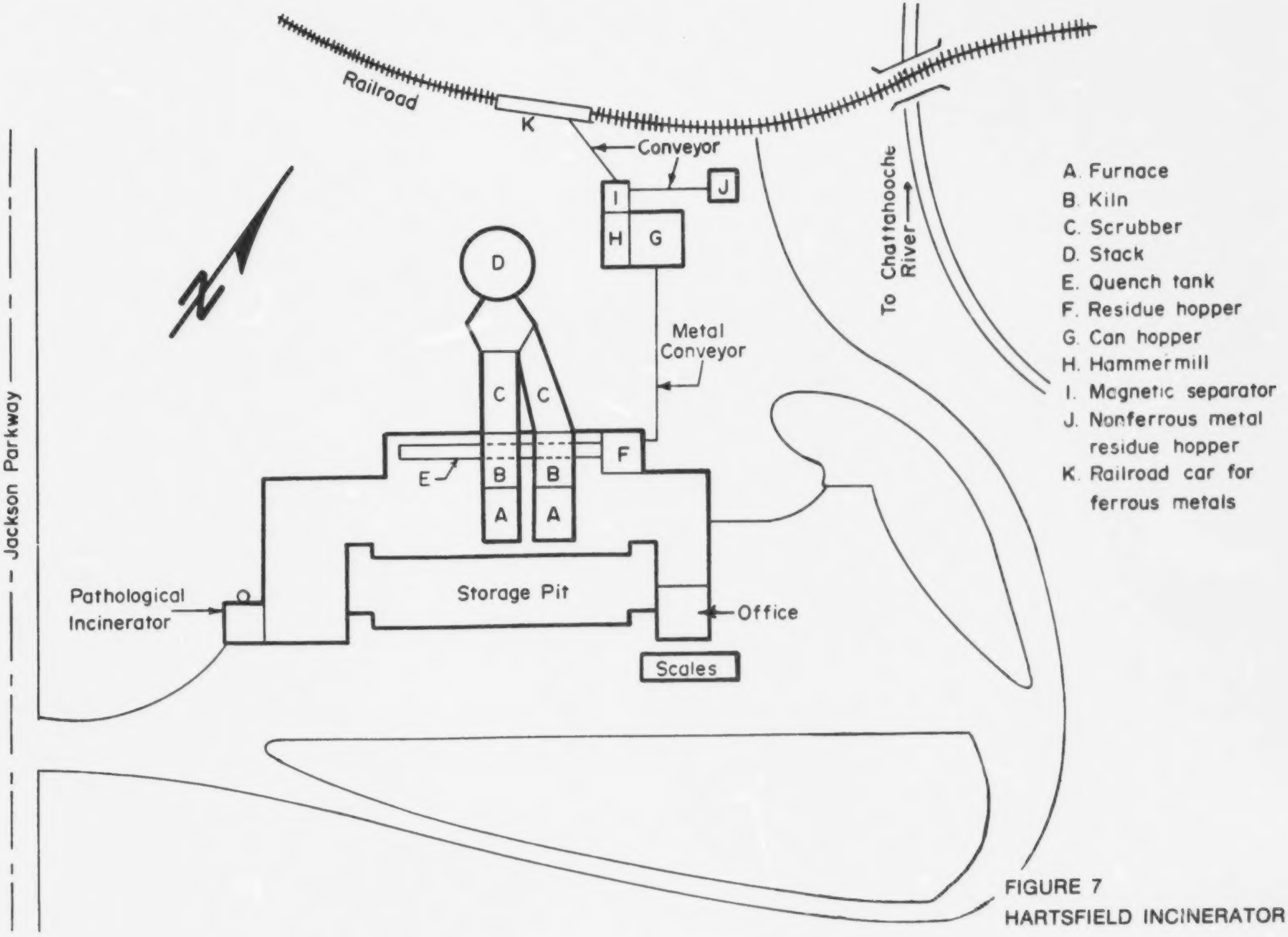

Railroad
K
Conveyor
I
J
H
G
D
Metal
Conveyor
C
C
B
B
A
A
F
E
Storage Pit
Office
Scales
Pathological
Incinerator
Jackson Parkway
To Chattahooche
River
A. Furnace
B. Kiln
C. Scrubber
D. Stack
E. Quench tank
F. Residue hopper
G. Can hopper
H. Hammermill
I. Magnetic separator
J. Nonferrous metal
residue hopper
K. Railroad car for
ferrous metals
N

FIGURE 7
HARTSFIELD INCINERATOR

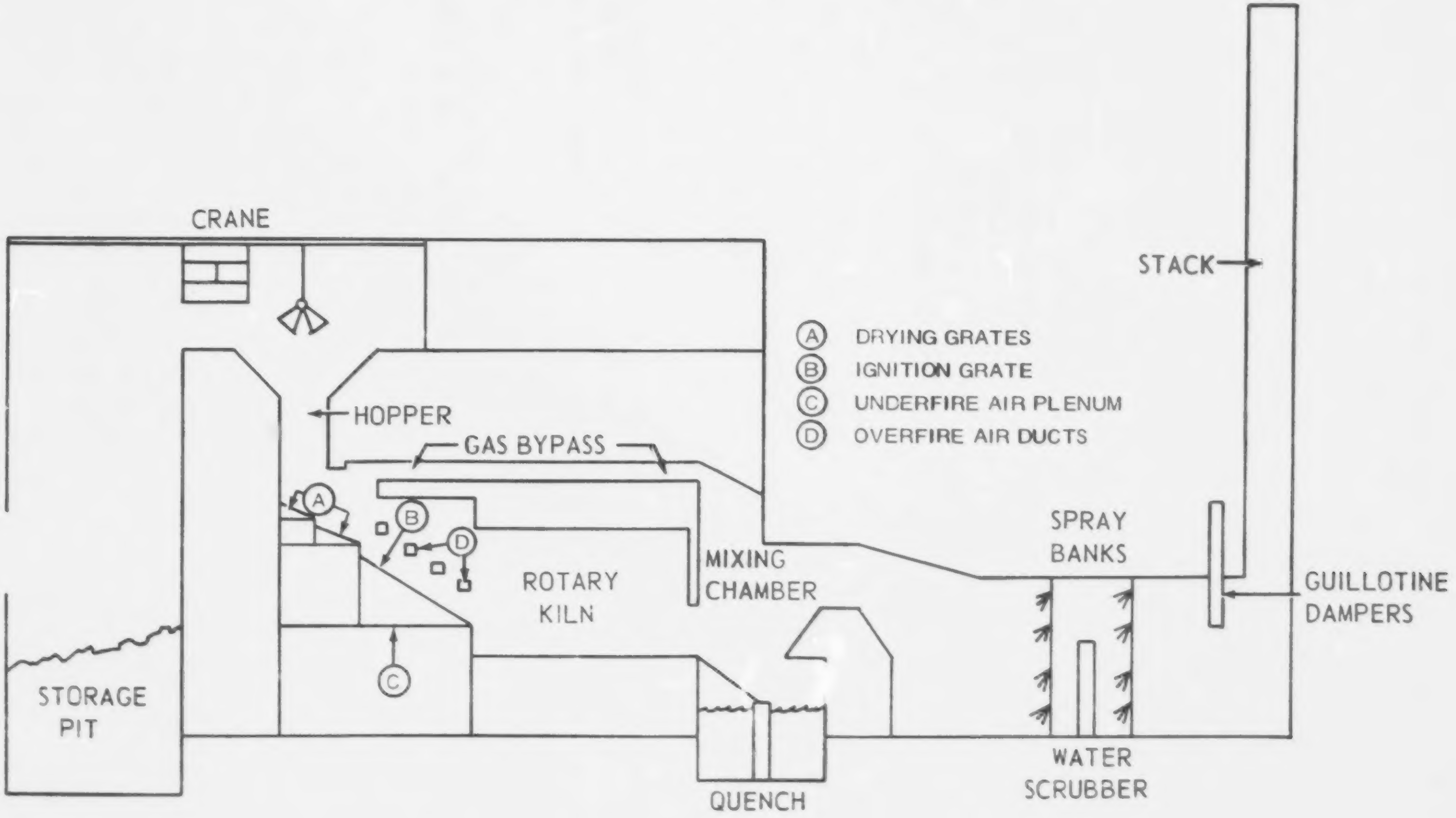

CRANE
HOPPER
GAS BYPASS
Ⓐ
Ⓑ
Ⓒ
Ⓓ
ROTARY KILN
MIXING CHAMBER
STORAGE PIT
QUENCH
SPRAY BANKS
WATER SCRUBBER
STACK
GUILLOTINE DAMPERS
Ⓐ DRYING GRATES
Ⓑ IGNITION GRATE
Ⓒ UNDERFIRE AIR PLENUM
Ⓓ OVERFIRE AIR DUCTS

FIGURE 8
SCHEMATIC OF HARTSFIELD INCINERATOR

Two test runs were made, one with 100 percent compacted wastes, another with 70 percent compacted waste and each with a control base run of normal uncompacted refuse. Forms used in this test are shown as Item L in the Appendix. Information obtained during the incineration test is given in three major sections: (1) The first section gives the recorded charge and residue for each test burn. (2) The second section gives operating rates for the ignition grates and rotary kiln for each test burn. (3) The final section provides the recorded operating temperatures for each test burn.

The following chart supplies the recorded charge of refuse and recorded residue assembled during each test burn.

Test No. 1	Pounds		Pounds
Base Charge	86,600	Residue*	23,720
Demo Charge			
100% Compacted	90,180	Residue	16,900
Test No. 2	**Pounds**		**Pounds**
Base Charge	87,720	Residue	32,140
Demo Charge			
Compacted Refuse	80,680		
Non-compacted	23,920		
Total Demo Charge	104,600	Residue	34,620

*Includes high moisture content from quench water.

Recorded operating rates of the ignition grates and rotary kiln for each test burn were tabulated by the unit operator during all tests. Each time there was a change in operating rate the operator noted the change and the time the change was effected. In order to obtain a weighted average operating rate, the incremental time in minutes was multiplied by the operating rate to yield a time factor. The time factor was then divided by the time in minutes to yield an average operating rate during each test of compacted and noncompacted refuse.

For charts demonstrating comparison of operating rates during incineration of compacted and non-compacted refuse see Appendix, Item M. Temperatures monitored during burn of compacted and non-compacted material are available in the Appendix, Item N.

The summary of the second test of incineration of compacted refuse is shown on the chart below. Base data refuse was consumed initially; then the demo mix was burned. The demo mix consisted of 77 percent compacted refuse, 23 percent non-compacted refuse.

SUMMARY OF INCINERATION TEST NO. 2

TOTAL REFUSE CHARGE	
Base Data - Non-Compacted	87,720 lbs.
Demo Data - Compacted	80,680 lbs.
Non-Compacted ---- 23,920 lbs.	104,600 lbs.
TOTAL CYCLE TIME	
Base Data	4 hrs. 15 min.
Demo Data	4 hrs. 35 min.
CONSUMPTION RATE	
Base data ----- 344 lb./min. or	10.3 ton/hr.
Demo Data ----- 380 lb./min. or	11.4 ton/hr.
(Rate capacity this unit ----- 10.4 ton/hr.)	
BURNING TEMPERATURE - IGNITION GRATE	
Base data	1800° F.
Demo data	1780° F.
BURNING TEMPERATURE - ROTARY KILN	
Base data	1625° F.
Demo data	1697° F.
REFUSE TRAVEL RATE - IGNITION GRATE	
Base data	32%
Demo data	39%
REFUSE TRAVEL RATE - ROTARY KILN	
Base data	42%
Demo data	49%
RESIDUE	
Base data	32,140 lbs.
Demo data	34,620 lbs.

A summary of the first incineration test of non-compacted and compacted material is shown below:

SUMMARY OF INCINERATION TEST NO. 1

TOTAL REFUSE CHARGE	
Non-compacted	86,600 lbs.
Compacted	90,180 lbs.
TOTAL CYCLE TIME	
Non-compacted	2 hrs. 45 min.
Compacted	3 hrs. 20 min.
CONSUMPTION RATE	
Non-Compacted --- 525 lb./min...or	15.75 ton/hr.
Compacted -------- 451 lb./min...or	13.53 ton/hr.
(Normal standard capacity this unit - 10.4 ton/hr.)	
BURNING TEMPERATURE - IGNITION GRATE	
Non-Compacted	1903° F.
Compacted	1966° F.
BURNING TEMPERATURE - ROTARY KILN	
Non-Compacted	1643° F.
Compacted	1717° F.
REFUSE TRAVEL RATE - IGNITION GRATE (% of 100)	
Non-Compacted	45.7%
Compacted	38.9%
REFUSE TRAVEL RATE - ROTARY KILN (% of 100)	
Non-Compacted	55.4%
Compacted	45.6%
RESIDUE	
Non-Compacted	23,720 lbs.
Compacted	16,900 lbs.

Recent cost studies completed by the City of Atlanta Finance Department have established a cost of $6.00 a ton to incinerate municipal waste in Atlanta. Burn rates (in tons per hour) will be established for each test run and a cost differential between compacted and non-compacted refuse is calculated in terms of cost per ton. Costs as calculated for non-compacted and compacted refuse during Test No. 1 and Test No. 2 are shown as follows:

Test No. 1

Non-compacted charge	86,600 lbs.
Non-compacted cycle time	2 hrs. 45 min.
Consumption rate	15.75 ton/hr.
Cost per hour	$94.20
Cost of this burn	$258.95

Compacted charge	90,180 lbs.
Compacted cycle time	3 hrs. 20 min.
Consumption rate	13.53 ton/hr.
Cost per ton	$81.18
Cost of this burn	$270.54

Test No. 2

Non-compacted charge	87,720 lbs.
Non-compacted cycle time	4 hrs. 15 min.
Consumption rate	10.3 ton/hr.
Cost per hour	$61.80
Cost of this burn	$262.65

Compacted mix charge		
compacted	80,680 lbs.	
non-compacted ..	23,920 lbs.	104,600 lbs.
Cycle time		4 hrs. 35 min.
Consumption rate		11.4 ton/hr.
Cost per hour		$68.40
Cost of this burn		$313.50

3. Questionnaire IV

The following is a copy of Questionnaire IV with the number of responses to the particular question in the appropriate blanks. All residents on the route did not reply, however, response was sufficient for an adequate sample.

QUESTIONNAIRE IV

1. Do sharp objects penetrate the bag?

11% every week, 4% every other week, 38% sometimes, 31% rarely, 14% never, 2% no response.

2. Is it possible for the lady of the house to remove the compactor bag from the unit? 67% Yes 29% No 4% No response

3. Do you seal your compactor bag before placing it on the curb?

36%	Yes
45%	No
17%	No, I put it in a garbage can.
2%	No response

4. Have you required service on the compactor since the last questionnaire?
12% Yes 84% No 4% No response

Residents were confused as to when they had received their last service call and confused the question further by answering yes if they had received a service call since the study began. The response to this question is unreliable.

5. How far is your house from the curb? This question was asked to determine if distance from curb had a significant bearing on dislike of curbside collection.

30%	0-55 feet
48%	55-100 feet
10%	100-150 feet
3%	200-250 feet
1%	300-350 feet
1%	500 feet
7%	no response

6. Do you hand carry your trash to the curb? 73% Yes 25% No, a wheeled aid is used and often, the car. 2% No response.

7. Do you find it inconvenient or undesirable to take your trash to the curb?
68% Yes 30% No 2% No response

Complaints concerning curbside collection are listed in the order of frequency.

1. Bags are too heavy.
2. Dogs create litter.
3. Too much trouble.
4. One pickup day a week is difficult to remember and if forgotten, it is more difficult to store trash for another week.
5. Street looks terrible.
6. Poor health.
7. Steep hill.
8. Bad weather.
9. House too far from curb.
10. Taxes are sufficient for backdoor collection.

8. Does the use of the compactor in the home reduce the burden of taking trash to the curb? 68% Yes 28% No 4% No response

Why not? Reasons are listed in order of frequency.

1. Did not have to take it to the curb before.
2. Bags are too heavy.
3. Amount of trash is the same even though it is compressed.
4. Resident wheels it to the curb anyway.
5. Dogs molest the trash.

9. Now that you are more accustomed to the compactor, is once a week collection adequate for your home? 90% Yes 8% No 2% No response

10. How do you rate the compactor as a home appliance?

41%	Excellent
39%	Good
11%	Fair
4%	Poor
5%	No response
17%	Luxury
64%	Convenience
7%	Necessity
4%	No response

D. Phase IV.

Curbside collection was again instituted during this phase and the final questionnaire of the project was completed.

1. Curbside Collection

Phase IV, curbside collection, was effected by the use of the open bed truck in order to determine whether or not compacted refuse could be collected by means of the open bed truck since this truck is less expensive than the compactor truck. Problems were immediately encountered with this method of collection and because of these problems, the open bed truck was used for six weeks curbside collection once a week, rather than 12 weeks as planned.

The primary problem with the open bed truck according to the Project Director was safety. The high lift required to load the open truck was an invitation for back injury. Refuse was lifted above the worker's head and presented a danger of debris falling into the eyes. (The amount of crushed glass in the compacted refuse increases the danger.) A third worker is required to stack refuse inside the truck, an unsanitary and unsafe area.

A secondary problem associated with the open-bed truck dealt with the number of trips to the disposal site. Two trips to the disposal site were required when using the compactor truck. Three to four trips to the incinerator were necessary when using the open bed truck. A canvas covering which was large and difficult to manipulate was necessary to cover debris in the truck and approximately ten minutes were spent putting the canvas in place and removing it for dumping. Maximum truck speed when the canvas was not in place was 10-15 miles per hour because of the blowing paper, therefore, transport time was much greater than with a rear loading compactor truck. A summary of demonstration data for this collection phase is shown on Table XX.

Cost tables for the open bed truck including operating costs were not possible because the City of Atlanta has no data available on operating costs of open body trucks in refuse collection. However, a comparative cost report of the open bed truck and the compactor truck has been prepared and is shown as follows on page 106.

TABLE XX

ENTIRE ROUTE
CURBSIDE COLLECTION
DEMONSTRATION DATA 6 WEEK SUMMARY OF 6 COLLECTION PERIODS

Equipment: 1 open bed truck
Crew: 1 waste collection driver, 3 waste collectors
Time is calculated in hours and tenths of an hour.

Collection Period	1	2	3	4	5	6	Total	Wk. Ave.
Total route time	4.7	4.6	4.6	5.5	4.6	4.4	28.4	4.7
Time collecting	2.2	2.5	2.5	2.9	2.7	2.6	15.4	2.6
Clean up time	.5	.3	.3	.3	.2	.1	1.7	.3
Ride time	1.5	1.5	1.4	1.6	1.5	1.6	9.1	1.5
Lost time	.2	.1	.1	.1		.1	.6	.1
Productive time (lb./hr.)	3757	4265	3831	3507	3757	3519		3750
Total time	4.4	4.5	4.3	4.8	4.5	4.3	26.8	4.5
Total stops	292	311	307	318	322	311	1861	310
Total pounds	13,900	17,060	14,940	15,780	15,780	14,780	92,240	15,373
Time Per Stop	.02	.01	.01	.02	.01	.01	.08	.01

DEPRECIATION AND DIRECT LABOR COST REPORT ON OPEN-BED VERSUS COMPACTOR TRUCK

Equipment Cost

OPEN-BED, 1971 International with high sides, 14 cu.yd	$ 6,015
GARBAGE TRUCK, 1971 International, rear loader, 20 cu.yds	$18,166

Labor Cost

SALARY, waste collector (average)	$ 6,760

Five Year Cost Analysis
Depreciation and Direct Labor*

Open-bed truck (requires 3 laborers)		Garbage truck (requires 2 laborers)
$ 6,015	Truck cost	$ 18,166
101,400	Labor cost	67,600
$107,415	Total	$ 85,766

SAVINGS on depreciation and direct labor by using garbage truck over five years .... $ 21,649
(5 years is life of each type truck.)

No data is available on operating costs of open body trucks in garbage collection. Only truck cost and labor cost are compared. It is expected that garbage trucks would require slightly more maintenance due to the packing system.

---

*Salary of truck driver is excluded from above calculations because there is no differential in salary for open-bed and garbage truck drivers.

PHOTO IX
CURBSIDE COLLECTION OPEN BED TRUCK

PHOTO X
PUTTING CANVAS IN PLACE
OPEN BED TRUCK

2. Questionnaire V.

The final questionnaire of this project was designed to obtain an overall opinion from the participants of the compactor operation, of curbside collection and of backdoor collection. The questionnaire with appropriate responses is as follows:

QUESTIONNAIRE V.

Answers to questions 1 and 2 concerning the chief advantages and disadvantages of the compactor were extremely varied and resident opinion conflicted on the use of the unit. For example, one resident stated the chief advantage to be the cleanliness and sanitary method of handling trash. Another resident stated the chief disadvantage was having trash in the house for a week and it was unsanitary. Such responses were in the minority, the majority of responses were clearcut with numerous supplementary responses by groups of a very few individuals.

A. The Compactor

1. What do you consider to be the chief advantage of the compactor?

79	less garbage
7	less garbage to take out
36	compacts trash
7	mashes bottles and cans
2	takes care of bottles
4	no messy garbage to handle
2	eliminates bags
1	bag fits can better
5	neat appearance of trash
5	cleanliness
32	storage of trash in 1 small unit
98	do not have to take trash to the can everyday
53	convenience
1	less work
6	saves time and steps
1	beautiful furniture
1	unit holds so much
1	do not like the unit
1	advantage to Sanitation Department
11	no advantage
3	no response

A summary of the above follows:

42%	reduces volume of trash by compacting with resultant advantages of elimination of garbage bags, neater appearance of trash and no messy bags to handle.
9%	storage of trash in one small unit.
27%	do not have to go to the trashcan every day.
17%	convenience and less work.
5%	miscellaneous

2. What do you consider to be the chief disadvantage of the compactor?

20%	no disadvantage
29%	weight, hard to unload, difficult to carry out the compactor bag, and bag hard to handle.
16%	odor
7%	no place to put compactor - location problem
4%	expense of compactor bags
4%	bags tear, no seal on bags
4%	changing bag
2%	difficult to clean
2%	too much extra work
2%	drawer difficult to open
2%	does not handle garbage adequately
2%	do not like having unit in kitchen for a week, unsanitary

Miscellaneous

6%	unit too small
	service inadequate
	noisy
	no response
	cord too short
	bag doesn't fit cans
	bugs
	takes up too much space
	messy and smelly
	not enough collection

Weight, odor and location are clearly the most important problems in connection with the compactor and these problems as a whole amount to less than half total resident response.

3. Do you rate the compactor deodorant spray?

61% satisfactory
9% unsatisfactory

29% less than satisfactory
1% no response

If you tested the new spray, did you find it:
76% satisfactory
2% less than satisfactory

4% unsatisfactory
Why? Compactor still smells and the odor of the new spray is unpleasant.

4. Do you rate the compactor bag:

78% satisfactory
18% less than satisfactory
3% unsatisfactory Why? Always tear, leaky.
1% no response

5. How do you rate the total performance of the compactor over the year's period?

45% excellent
46% good
7% fair
2% poor

6. Are you purchasing the compactor because:

21% the price is right
21% it is a work saver
39% the price is right and it is a work saver
8% no response

I am not purchasing the compactor because:

1% the price is not right
3% no place for the unit
4% dissatisfaction with the unit totally

1% too small a family
1% moving
1% cannot afford

B. Curbside Collection

1. What do you consider the chief problem with curbside collection?

25%	weight or bulk of trash
26%	trip to the curb in varying weather
26%	litter created by dogs
7%	unsightly streets because of cans
11%	no problem
2%	trying to remember to put the trash out
2%	no response

2. If collection were curbside, would a compactor be a help to you?

78%	yes
20%	no
2%	no response

3. If the compactor bag is properly sealed at the top, is it possible for dogs to get into the bag?

64%	yes
33%	no
3%	no response

4. If collection were curbside and a compactor was in the home, which would you prefer:

72%	collection 1 time a week
27%	collection 2 times a week
1%	no response

5. Once a week, what do you take to the curb?

74% of the residents usually have 1 or 2 parcels at the curb, the parcel may be a can, compactor bag or plastic bag or any combination of the three. Answers are not precise because respondent stated 1 bag, sometimes 2, etc. 19% of the residents take three parcels to the curb. The remainder, 7%, take more than three items to the curb.

6. If there was a question of higher taxes and collection at the backdoor twice a week or curbside collection or collection one time a week at the backdoor with a compactor in the home, which would you choose?

5%	higher taxes with backdoor collection twice a week
9%	curbside collection twice a week
85%	compactor in the home with backdoor collection 1 time a week
1%	no response

C. Backdoor Collection

1. With backdoor collection, is the compactor a help to you?

85% Yes 14% No 1% No response

2. With a compactor in the home, would backdoor collection once a week be satisfactory?

92% Yes 8% No

3. Would backdoor collection once a week be possible without a compactor in the home?

32% Yes 68% No

4. Do dogs ever strew trash at the backdoor?

42% Yes 58% No

5. How many cans do you fill once a week at the backdoor with a compactor in the home?

84% of the residents stated they place 1 or 2 parcels at the backdoor. As before, this could be any assortment of compactor bag, can or cans or plastic bag. 12% of the residents placed 3 parcels at the backdoor and the remaining 4% had more than 3 parcels of trash at the backdoor.

In summary, the majority of the residents enjoy the reduction of volume by compacting with the resultant advantages of elimination of garbage bags, neater appearance of trash, no messy bags to handle, storage of trash in one small unit, convenience and the fact they do not have to go to the trashcan every day. Chief disadvantages of the compactor is the weight of the bag and that it is hard to handle. Most residents are satisfied with the deodorant spray and the compactor bags and 91 percent of the residents rate the compactor excellent or good after a year's use.

Chief problems identified with curbside collection were the weight and bulk of the trash, trip to the curb in varying weather and the litter created by the dogs. The majority of residents felt the compactor did make curbside collection easier and actually preferred curbside collection once a week rather than two times a week.

Most residents felt the compactor was a help with backdoor collection and felt collection once a week would be satisfactory if a compactor was in the home.

Conclusions and Recommendations are on page 5.

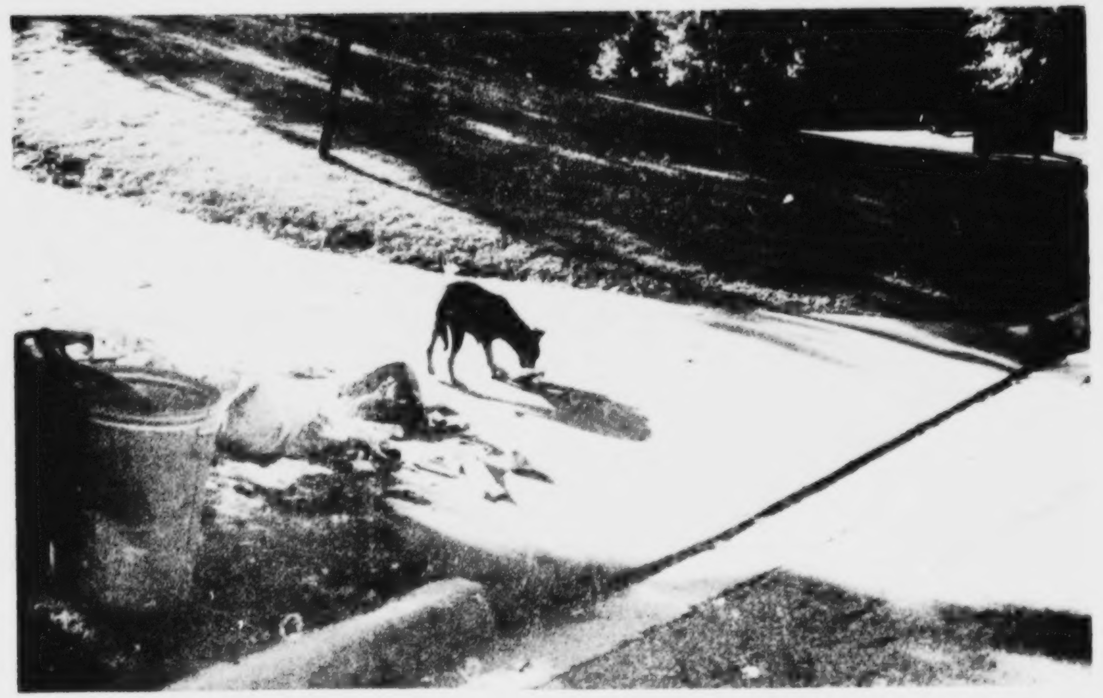


PHOTO XI
DOGS SCATTERING REFUSE

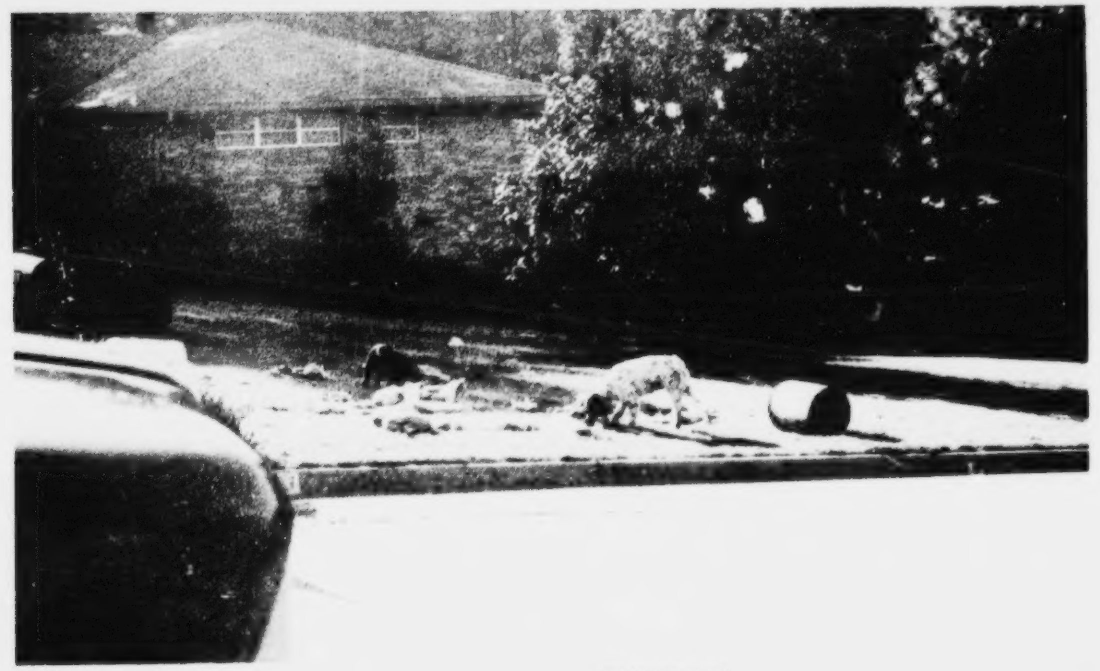


PHOTO XII
DOGS AT WORK ON CURBSIDE REFUSE

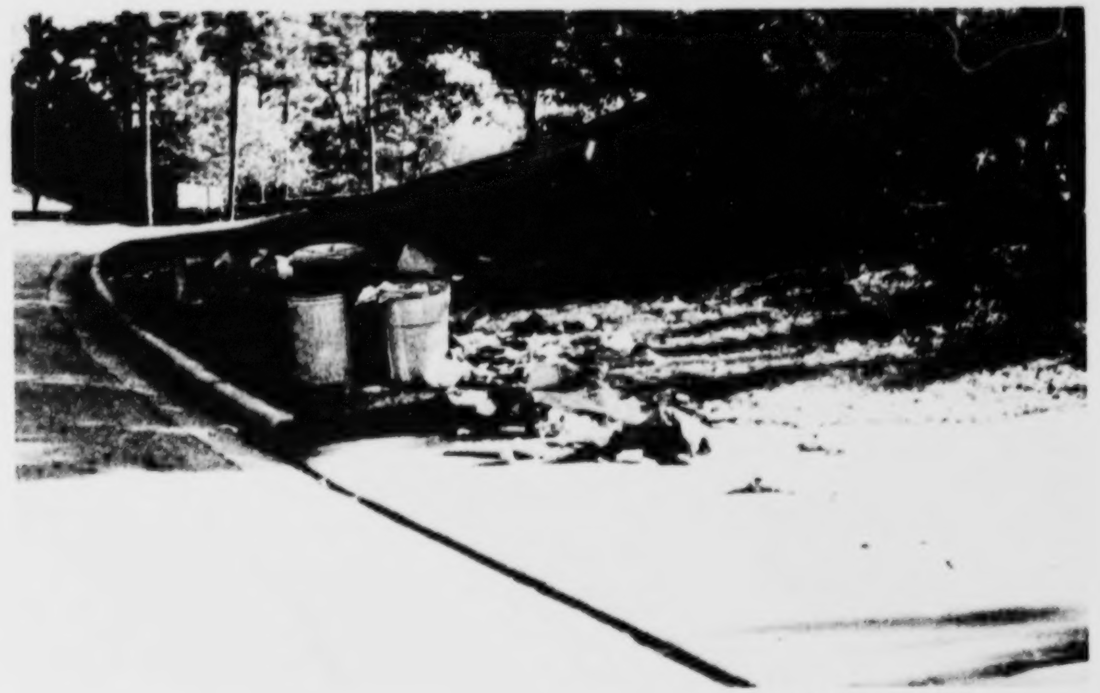


PHOTO XIII
AFTER DOGS ARE FINISHED

PHOTO XIV
TYPICAL HOME ON PROJECT ROUTE

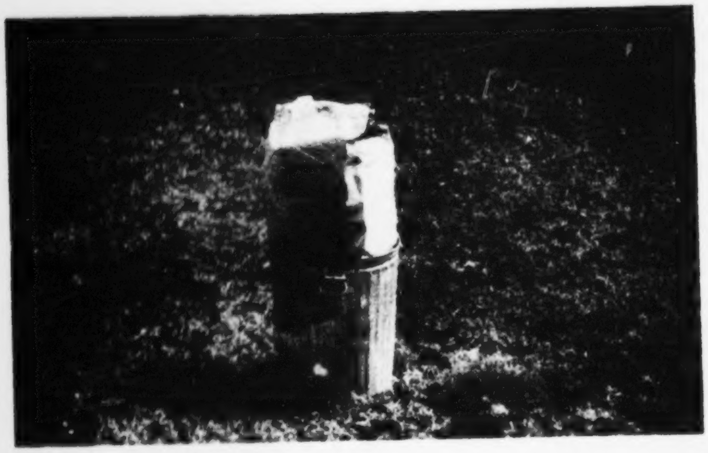


PHOTO XV
COMPACTOR BAG

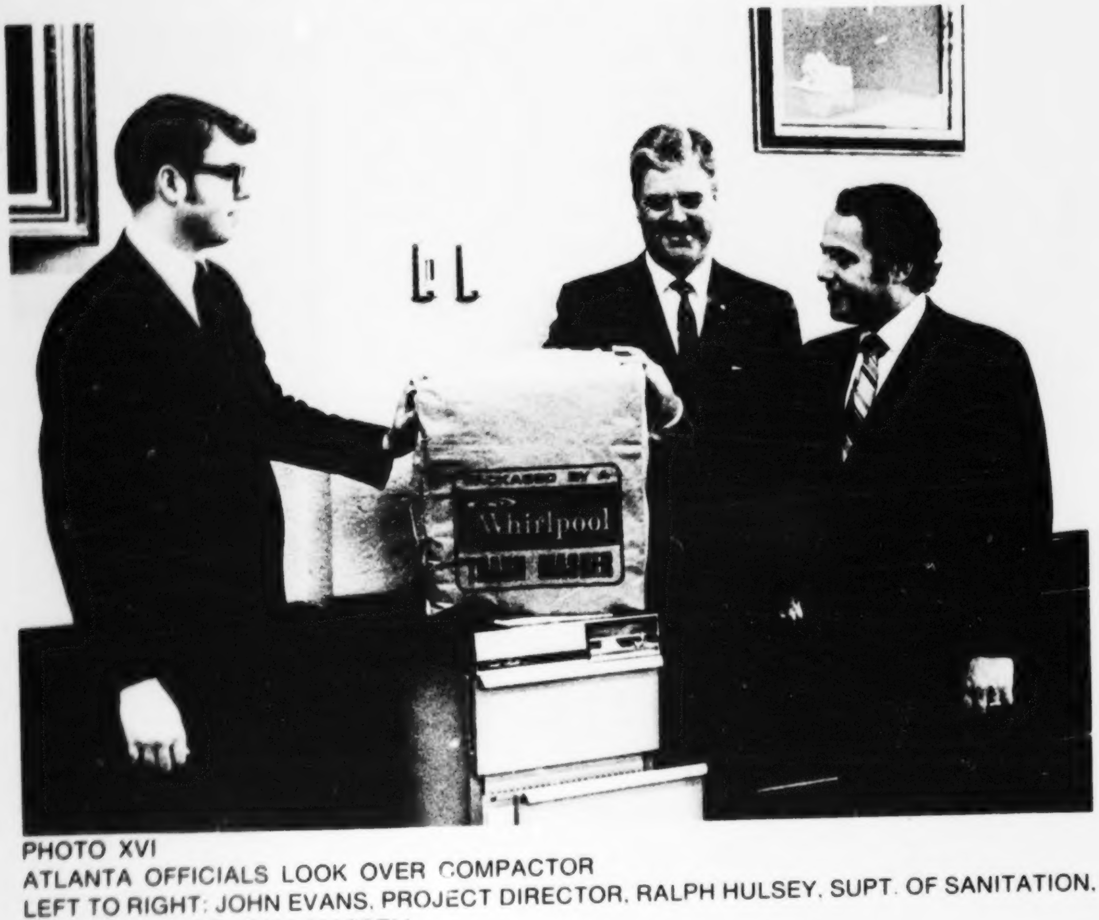

PACKAGED BY A
Whirlpool
TRASH MASHER

PHOTO XVI
ATLANTA OFFICIALS LOOK OVER COMPACTOR
LEFT TO RIGHT: JOHN EVANS, PROJECT DIRECTOR, RALPH HULSEY, SUPT. OF SANITATION, FORMER MAYOR, SAM MASSELL.

GLOSSARY

Bags	Refer to Compactor Bags.
Base Data	Data gathered during routine collection of the project route, that is, collection backdoor twice a week and curbside twice a week.
Cans	Conventional metallic, fiberboard or other re-useable refuse container fitted with a handle and a lid.
Compacted Refuse	Refuse taken from homes in which household compactors have been placed.
Demo Data	Data gathered after the household compactors were placed on the route during backdoor and curbside collections utilizing varying crews and techniques.
East Liddell Route	This route is normally serviced backdoor twice a week with a compactor truck, two satellites, truck driver and two satellite drivers.
Entire Route	Refers to East Liddell and West Maddox during curbside collection and mention of entire route denotes curbside collection unless backdoor is specified.
Non-Compacted Refuse	Refuse taken from homes that do not have a household refuse compactor.
Odds	Any extra items placed for collection that are not in a can or compactor bag.
Waste Collector II	A walking crewman.
Waste Collector III	A satellite vehicle driver.
Waste Collector Driver	Driver of the compactor truck.

Preceding page blank

BIBLIOGRAPHY

Garbage pollution: what you can do to help. Better Homes and Gardens, 49(10):14, 18, 22, 125, Oct. 1971.

McLean, Mary. Planning for solid waste management. Report No. 275. Chicago, Planning Advisory Service, Dec. 1971. pp. 13-14.

Willman, Martha. Trash collector gives compactors to homes. Los Angeles Times, Feb. 11, 1973, Sect. 11, p. 4.

Preceding page blank

CITY OF ATLANTA

APPENDIX A

NEWS RELEASE

For Further Information
Call: Rosemary Thomas
Research and Information Officer

For Release November 16, 1970

Atlanta Mayor Sam Massell today announced that the City has received notice of a $92,120 grant from the Department of Health, Education and Welfare. The grant is to be used for a study in a demonstration project on trash collection techniques and procedure. In commenting on the ammouncement, Mayor Massell said, "One of the most pressing problems facing the city today is that of collection and disposal of residential refuse. Volume and cost are overwhelming."

"Today one out of ten tax dollars in the average American city is spent for the collection and disposal of residential trash. Since the collection expenditures amount to approximately 80 percent of most municipal sanitary budgets, Atlanta has been looking for a sound way to improve the system and reduce the cost. The demonstration project is an experiment in this direction. We can reduce collection costs if we can reduce collection and volume at the primary source."

One method of reducing volume can be realized by utilizing a new home appliance recently introduced by the Whirlpool Corporation called the Trash Masher compactor. This unit compacts about a week's trash (about three 20-gallon trash containers full) for the average family of four into a neat bag a little larger than the average grocery bag.

The Mayor pointed out that, "by utilizing equipment such as the Trash Masher compactor, trash collection would only be necessary once a week; thereby, enabling us to cut the cost of collection."

Mayor Massell went on to explain that "the test program will include 400 households in the City of Atlanta. This gives us a clearly designed representative model with which to measure the potential effectiveness of a similar type program for the entire city. I feel that Atlanta is very fortunate to have this demonstration grant and the opportunity to discover a better method of solid waste management, not only for our city, but possibly for the nation."

Preceding page blank

APPENDIX B

November 23, 1970

Dear Resident of Southwest Atlanta:

Your area is under consideration as a test site for a Demonstration Study of the Household Refuse Compactor.

The Household Refuse Compactor Demonstration Project, recently described in the radio, television and newspaper media is sponsored by the Public Health Service of the Department of Health, Education and Welfare and the Sanitation Department of the City of Atlanta. It is an effort to solve some of the ever increasing problems of trash collection. Today one out of ten tax dollars is spent for collection and disposal of residential trash. For this reason Atlanta has been looking for a way to improve the system and reduce the cost.

We will need your help. The demonstration Project introduces a home appliance called the TRASH MASHER Compactor. This unit compacts a week's trash for the average family of four into a neat little bag about the size of a grocery bag. The trash masher, with your consent, will be placed in your home for 12 months at no cost to you. You will be able to test the trash masher for us. Every three months a Project Representative will contact you with a supply of bags and a questionnaire to evaluate the performance of the unit.

Are you interested? If so, please fill out the enclosed card. The area will be selected on the basis of interest by those who are to participate. If your area is selected, a Project Representative will visit you during the week of December 7-11. He will explain the Project fully and will solicit your participation.

Yours very truly,

R. E. Hulsey

R. E. Hulsey
Superintendent of Sanitation

APPENDIX C
ATLANTA HOUSEHOLD REFUSE COMPACTOR DEMONSTRATION PROJECT
DATA FORMS - EAST LIDDELL ROUTE

Date: ____________________ Area: ________________________ Truck No: ________

No. Scouts ________ Type Service __________________ Total Lbs: ______________

	Name:	Clock No:	Daily Rate:
Driver			
Man No. 1			
Man No. 2			
Man No. 3			
Man No. 4			

Total Route Mileage: ________________ Total Non-Route Mileage: __________________

Total Route Time: __________________ Total Non-Route Time: ____________________

Man No.	No. Stops	Collect Tm	Dump Tm	Wait Tm	Ride Tm	Pack Tm	Lost Tm	Total Tm
1								
2								
3								
4								
Total								

APPENDIX C CONTINUED
ATLANTA HOUSEHOLD REFUSE DEMONSTRATION PROJECT
DATA FORMS - EAST LIDDELL ROUTE

SECTION I: Date: ____________ Weather: ____________ Collection area: ____________

Type Service: ____________ Disposal type: ____________ Location: ____________

Crew size: ____________ Observer: ____________

Truck Data: Body Manufacturer: ____________ Capacity: ______(yds) Type: ____________

Hopper size: (yds) Chassis: ____________ Axles: ____________ Max load: ____________(lbs)

Scout Data: No. used: ________ Type: ____________ Capacity: ____________(yds)

SECTION II:

Route Information	Wristwatch Time:	Odometer Mileage:	Net Weight:
Leave station	________	________	
Arrive route	________	________	
Leave route (1st load)	________	________	
Arrive disposal site	________	________	
Leave disposal site	________		
Arrive route	________	________	
Leave route (2nd load)	________	________	
Arrive disposal site	________	________	
Leave disposal site	________		
Arrive station	________	________	
Lunch			
Leave route	________	________	
Arrive lunch	________	________	
Leave lunch	________		
Arrive route	________	________	

____

____

____

____

APPENDIX C CONTINUED
ATLANTA HOUSEHOLD REFUSE DEMONSTRATION PROJECT
DATA FORMS - EAST LIDDELL ROUTE

SCOUT 1 - No:				SCOUT 2 - No:			
Stops	Collection Time	Lost Time	Reason	Stops	Collection Time	Lost Time	Reason

APPENDIX C - CONTINUED

Definition of terms applicable to the East Liddell Route, base data collection and Table IX.

1. Base data - information collected before the compactors were placed in service on the project route.

2. Time collecting is measured from the time the scout leaves the collection truck until the scout returns to the truck to dump its load. Actually, all collection time is not spent in collection itself; that is, this time includes traveling to each collection point, effecting collection, emptying refuse into the scout, repeating this process until scout is full and returning to collection truck.

3. Wait time occurs when both scouts need to dump at the same time. Since this is not possible, one scout must wait for the other to finish. The resulting delay is a form of lost time.

4. Ride time is the time man is transported to the next pickup point.

5. Lost time can include numerous unproductive activities. They include breakdown and repair, accidents, rest, drink water, tie shoe and others. Any significant difference in lost time in the various stages is purely accidental and more dependent on weather than anything else.

6. Total route time is the time actually spent on the route and includes time collecting for the one man who required the most time to collect the route.

7. Total time is a total of time collecting, clean up, ride, lost, wait, break down and so forth. Any discrepancy between total time and sum of actual time shown is due to rounding the figures off to tenths of an hour.

APPENDIX D

COST TABLES

Basic cost of collection in the City of Atlanta is as follows:

Operating Cost of 1 Compactor Truck

Item	Per Hour	Per Day**	Per Week***
Fuel	.35	2.77	5.54
Oil	.00	.07	.14
Grease	.00	.02	.04
Tires	.16	1.25	2.50
Parts	.30	2.37	4.74
Labor	.35	2.83	5.66
Depreciation*	1.46	11.66	23.32
TOTAL	$2.62	$20.97	$41.94

*Based on a 213 day use and five year life.
**Based on an eight hour working day.
***Based on two eight hour working days.

Labor Cost

Crew	Per Hour	Per Day***	Per Week****
Waste Collection Dr.	$ 3.68	$ 29.45	$ 58.90
Waste Collector III*	3.39	27.10	54.20
Waste Collector II**	3.25	26.00	52.00

*Waste Collector III operates the satellite vehicles.
**Waste Collector II is a walking crewman.
***Based on an eight hour working day.
****Based on two eight hour working days.

APPENDIX D - CONTINUED

Operating Cost of Satellite Vehicles

Item	Per Hour	Per Day**	Per Week***
Fuel	$ .12	$ .93	$ 1.86
Oil	.00	.02	.04
Grease	.00	.01	.02
Tires	.03	.23	.46
Parts	.19	1.55	3.10
Labor	.21	1.70	3.40
Depreciation*	.27	2.15	4.30

*Based on 225 operating days, five year life.
**Based on an eight hour working day.
***Based on a two day week.

APPENDIX E
ATLANTA HOUSEHOLD REFUSE COMPACTOR DEMONSTRATION PROJECT
DATA FORMS - WEST MADDOX ROUTE

Date ____________________ Area ____________________ Truck No. ____________

No. Men ____________________ Type Service ______________ Total lbs. ____________

	Name	Clock No.	Daily Rate
Driver:			
Man 1			
Man 2			
Man 3			
Man 4			

Total Route Mileage ____________________ Total Non-Route Mileage ____________________

Total Route Time ____________________ Total Non-Route Time ____________________

Man No.	No Stops	Collection Tm	Dump Tm	Wait Tm	Ride Tm	Pack Tm	Lost Tm	Total Tm
1								
2								
3								
4								
Total								

APPENDIX E CONTINUED
ATLANTA HOUSEHOLD REFUSE DEMONSTRATION PROJECT
DATA FORM - WEST MADDOX ROUTE

SECTION I: Date: __________ Weather: __________ Collection area: __________

Type Service: __________ Disposal type: __________ Location: __________

Crew size: __________ Observer: __________

Truck Data: Body Manufacturer: __________ Capacity: ______(yds) Type: __________

Hopper size: (yds) Chassis: __________ Axles: __________ Max load: __________(lbs)

Scout Data: No. used: ______ Type: __________ Capacity: __________(yds)

SECTION II:

Route Information	Wristwatch Time:	Odometer Mileage:	Net Weight:
Leave station	__________	__________	
Arrive route	__________	__________	
Leave route (1st load)	__________	__________	
Arrive disposal site	__________	__________	
Leave disposal site	__________		
Arrive route	__________	__________	
Leave route (2nd load)	__________	__________	
Arrive disposal site	__________	__________	
Leave disposal site	__________		
Arrive station	__________	__________	
Lunch			
Leave route	__________	__________	
Arrive lunch	__________	__________	
Leave lunch	__________		
Arrive route	__________	__________	

____

____

____

____

APPENDIX E CONTINUED
ATLANTA HOUSEHOLD REFUSE DEMONSTRATION PROJECT
DATA FORM - WEST MADDOX ROUTE

SCOUT 1 - No:				SCOUT 2 - No:			
Stops	Collection Time	Lost Time	Reason	Stops	Collection Time	Lost Time	Reason

APPENDIX E CONTINUED

Definition of terms applicable to the West Maddox route and base data collection as enumerated on Table X.

1. Time collecting is defined as the period of time elapsed from the time the collector leaves the truck to the time he returns after collection is made. Collection time, when measured this way, includes the time it takes to walk from the truck to the pick-up point and return trip as well as the actual time involved in collection of refuse. Collection time is the most important parameter in this phase.

2. Ride time is the time taken when a man is transported to the next pickup point.

3. Pack time is a form of non-productive time necessary to operate the compaction mechanism of the collection truck.

4. Wait time occurs when a collector emerges at the curb ahead of the collection truck and must wait a period of time before he can dump his barrel.

5. Lost time is an all-inclusive category for all miscellaneous types of non-productive time such as tie shoe lace, break, receive instructions and so forth.

6. Pounds of refuse collected is determined by weighing the collection truck immediately upon completion of the test route.

7. Total route time is the time actually spent on the route and includes time collecting for the one man who required the most time to collect the route.

8. Total time is a total of time collecting, clean up, wait, ride, pack, lost and so forth. Any discrepancy between total time and sum of actual time shown is due to rounding the figures off to tenths of an hour.

APPENDIX F
ATLANTA HOUSEHOLD REFUSE COMPACTOR DEMONSTRATION PROJECT
DATA FORMS - CURBSIDE COLLECTION

Date ____________ Area ____________ Truck No. ____________

No. Men ____________ Type Service ____________ Total lbs. ____________

	Name	Clock No.	Daily Rate
Driver:			
Man 1			
Man 2			
Man 3			
Man 4			

Total Route Mileage ____________ Total Non-Route Mileage ____________

Total Route Time ____________ Total Non-Route Time ____________

Man No.	No Stops	Collection Tm	Dump Tm	Wait Tm	Ride Tm	Pack Tm	Lost Tm	Total Tm
1								
2								
3								
4								
Total								

APPENDIX F - CONTINUED
ATLANTA HOUSEHOLD REFUSE COMPACTOR DEMONSTRATION PROJECT
DATA FORMS - CURBSIDE COLLECTION

Stops	No. Cans	No. Bags	No. Other	Begin Collection	Begin Travel	Begin Other	Explanation

APPENDIX F - CONTINUED
DEFINITION OF TERMS APPLICABLE TO CURBSIDE SERVICE AS SHOWN ON TABLE XI
DESIRED DATA RESULTS

Analysis of curbside collection affords our most valuable means of determining the value of the household compactor. Unlike backdoor collection, the curb method allows the observer to visually examine the entire collection procedure and therefore obtain more accurate and reliable data. This phase is the only one in which the observer has the opportunity to count the number of cans, bags, and parcels that are placed out for collection. The most important determination to be made is whether or not significant time savings can be attributed to (1) fewer items handled and (2) more disposable containers as a result of the household compactor.

DEFINITION OF TERMS:

(1) Number of cans is visually noted by the observer before collection begins. The size of cans used is generally 32 gallons, however, there are several smaller and larger sizes in use.

(2) Number of Trash Masher bags are those visually in evidence before collection is effected. Many of the participants put the compactor bag in a garbage can - in this case only the can was counted. Other residents put the compactor bag in an opaque plastic bag - in this case it would be recorded as a plastic bag.

(3) Plastic bags and all other disposable bags are noted in this classification.

(4) The number of boxes is noted in the next column. Like Trash Masher bags and plastic bags, boxes are disposable containers.

(5) Collection time is measured from the time the collector departs from the truck until he begins the next activity, such as traveling. Collection time in this phase is measured for the collection team (2 men), not for each man individually. Collectors were urged to work together in order to minimize lost time. Collection time is by far the most important parameter of this phase since it depends primarily on the number of disposable and non-disposable containers which must be handled.

(6) Travel time is a measure of time between pick-up points. Travel time is a function of the distance between homes and the speed of the truck and is uneffected by compacted or non-compacted refuse.

(7) Packing time is a measure of lost time due to the operation of the packing mechanism. If collection of refuse is not interrupted by this action, then no time is charged to Packing. Packing time is a function of the type of equipment used and is of no major importance.

(8) Clean-up time is a form of lost time spent in collecting loose litter from the street and curb area. This litter is mainly attributable to scattering by animals and in a lesser instance to negligence on the part of the resident. Comparison of clean-up time between phases I and II will indicate the frequency and severity of the problem.

(9) Lost time is the same, for each phase, all inclusive for tying shoe laces, breaks, giving instructions and so forth.

APPENDIX G
SEGMENTS - CURBSIDE COLLECTION

(1) Sequoyah Dr.
(2) R. of Margaret Mitchell to Peachtree Battle
(3) Peachtree Battle to Moores Mill Rd.
(4) Moores Mill (r) to Margaret Mitchell (1 house)
(5) Margaret Mitchell to Peachtree Battle; then R. side to Ridge Valley Rd.
(6) Ridge Valley Rd. from Margaret Mitchell to Ridge Valley Ct.
(7) Ridge Valley Ct.
(8) Ridge Valley Rd. from Ridge Valley Ct. to Wesley Pky.
(9) Wesley Pky. to Margaret Mitchell
(10) Ridge Valley Rd. from Wesley Pky. to Sequoyah
(11) W. Wesley from Sequoyah to Margaret Mitchell
(12) Margaret Mitchell from W. Wesley to Wesley Pky.
(13) W. Wesley from Moores Mill to Bohler Rd.
(14) Bohler Ct.
(15) Bohler Rd. (two parts)
(16) Battleview Dr.
(17) Peachtree Battle from Bohler Rd. to Moores Mill
(18) Moores Mill R. side to Wesley
(19) Moores Mill R. side from Wesley to Peachtree Battle
(20) Moores Mill R. side to Ridgemore Rd.
(21) Ridgemore Rd. to Ridgemore Pl.
(22) Ridgemore Pl.
(23) Ridgemore Rd. from Ridgemore Pl. to end
(24) Moores Mill R. side to Warren Rd.
(25) Warren Rd.
(26) Ridgewood Rd. from Warren Rd. to Moores Mill
(27) Moores Mill R. side to Ridgewood Terr.
(28) Ridgewood Terr.

APPENDIX H
ATLANTA HOUSEHOLD REFUSE COMPACTOR DEMONSTRATION PROJECT

QUESTIONNAIRE I

Name ______________________________ Telephone ____________
Address ______________________________
____

Personal Information:

Please list all members of the household and include educational level, age and employment:

Name	relation	age	education	employment

List all others on the back of this questionnaire.

Income (please check one category)
$5,000 - $15,000 ______________ $15,000 - $25,000 ______________
$25,000 - $40,000 ______________ $40,000 - up ______________

Do you own home ________ or rent? ________
Do your children attend public schools ______ or private schools ____?
How many cars do you own? ________
Do you have a maid? ________ How often? ______________.

On this questionnaire we are not concerned with the trashmasher unit because we do not feel it has been in the home long enough for a proper analysis. These questions are directed to you as though you did not have a trashmasher at all.

Where in the house do you have trashcans located:

How many? How often do you empty it?		How many? How often do you empty it?	
Bedroom 1	______________	Playroom	______________
Bedroom 2	______________	Dining Room	______________
Bedroom 3	______________	Kitchen	______________
Bedroom 4	______________	Living room	______________
Bath 1	______________	Den	______________
Bath 2	______________	Garage	______________
Basement	______________	Other	______________

How many large outside cans do you have? ________ Do you fill these cans once a week? ________ twice a week? ________ four times a week? ________ Could you use collection service three times a week? ________ four times a week? ________ On the average how many meals a week does your family eat out? ________ Do you have a garbage disposal? ________ Do you purchase more frozen goods ________ or canned goods ________? Are your newspapers taken to the schools ________ or are they a part of your trash? ________ Are your magazines taken to the schools? ________ or are they a part of your trash? ________ Do you purchase many paper products, paper towels, napkins, etc.? ________ Would you say your trash is largely paper ________, metal ________ or garbage ________?

Comments:

APPENDIX I
HOUSEHOLD REFUSE COMPACTOR DEMONSTRATION PROJECT
LANDFILL TEST DATA SHEET

TEST CELL NO: ____________________

Tractor Operator ____

Date ____________________ Tractor Shop No: __________________

Machine hours worked ____________ Buckets Cover Dirt Used ________________

Number of compaction passes made _________________________

First Load: Number of pounds disposed _____________________

Cubic Yards Disposed _________________________

Second Load: Number of Pounds Disposed _____________________

Number of cubic yards _________________________

Third Load: Number of Pounds Disposed _____________________

Cubic Yards Disposed _________________________

Fourth Load: Number of pounds disposed _____________________

Cubic Yards Disposed _________________________

APPENDIX J
ATLANTA HOUSEHOLD REFUSE COMPACTOR DEMONSTRATION PROJECT

QUESTIONNAIRE II

Please complete this form and mail immediately in the enclosed envelope. Your cooperation is greatly appreciated.

Name ____

Address ____

How many persons reside at this address? ________ Members of this household attending college elsewhere? ______________________________

If you have a pet, please specify kind and number. ____________________
(For example, dog (1) cat(2)

1. a Is this Trash Masher currently being used in your home?

YES ( ) Please fill out the remainder of the questionnaire.
No ( ) Please answer Question No. 2 and then explain why you are not using it in the space provided for COMMENTS.

b. What percentage of the refuse (garbage and trash) in your home would you say you put in the Trash Masher? __________ %.

c. Please check any of the following items which you do NOT put in the Trash Masher.

________________ Newspapers/Magazines ________________ Glass Items

________________ Food Scraps ________________ Tin Cans

________________________ Other (specify)

2. a. Where is your Trash Masher located? ______________________________.

b. Would you, if you had space, relocate your Trash Masher? ________ Where? ______
____.

c. How convenient do you consider the unit? __________ Excellent; __________ Good; __________ Fair; __________ Poor. Why do you describe it that way? ______________________________.

3. a. Do you have a garbage disposal? ____________________

b. Do you use your garbage disposal as you previously have? __________ Or do you now place the majority of your garbage in the Trash Masher? ____________________
____.

4. a. Do you place garbage and trash in the Trash Masher loosely?________ Or do you place garbage and trash in the Trash Masher in a paper bag? ________________________

b. Do you find your Trash Masher unduly noisy? ____________________________.

c. Do you have a problem keeping your Trash Masher clean?______________________

d. Do you have a problem with odor from the Trash Masher? ______________________

5. a. How often do you change the bag in the Trash Masher? ______________________
Every _________ days.

b. Why do you change it then? ____

c. Who in the household usually removes the full bag from the Trash Masher?______

d. Who in the household usually takes the bag out of the house? ________________

e. Who in the household usually puts the new bag into the Trash Masher?__________

f. How do you store full bags until collection day?___________________________
In a receptacle ______________________________________ Not in a receptacle.

6. a. Now that you are using the Trash Masher, is once a week collection adequate for your needs? ____
YES (   ) NO (   )
How is it not adequate?____

b. What would you consider to be the maximum number of days your household should be able to go between collections?
Days.______________

c. Have you required service on your Trash Masher? ______________

How often?________________For what reason? ___________________________

d. Have you experienced a reduction in the volume of trash generated for collection day?
How much before?____
How much now?____

COMMENTS: ____
____
____
____
____

APPENDIX K

QUESTIONNAIRE III

Once again, we are asking you a number of questions about the Trash Masher compactor in your home. We realize that you may have already answered some of them in a previous survey but would you do it again. Your cooperation is greatly appreciated.

1. Now that you have been using the Trash Masher Compactor for some time, how would you rate your satisfaction with the unit?

   Completely satisfied ( )
   Satisfied ( )
   Somewhat dissatisfied ( )*
   Completely dissatisfied ( )*
   Not now using the unit ( )*

   If not satisfied or not using the unit, why is that?

   ____

   ____

2. A. Where in your home do you have the Trash Masher? ______________

B. If in the kitchen, please complete the drawing enough to show the relationship of the Trash Masher Compactor to the sink.

C. Where would be the best location for you? ______________
(If you can, draw it in the diagram above and label it "best".)

D. Why would it be best in that location? ______________

____

E. Has the Trash Masher Compactor always been located where it is now?

Yes ( ) No ( )

Where was it originally? ______________

Why was it moved? ______________

____

APPENDIX K - CONTINUED

3. A. Was curbside collection better overall
before installation of the Trash Masher compactor ( )
after installation of the Trash Masher compactor ( )

B. Was backdoor collection better overall
before installation of the Trash Masher compactor ( )
after installation of the Trash Masher compactor ( )

4. Do you normally operate the Trash Masher Compactor...

Each time an item is added ( )
Usually just when larger items are added ( )
Each time the container gets full ( )
Once a day ( )
Other: ____

5. Do you use the key to lock the Trash Masher Compactor?

Yes ( ) No ( )

6. A. What percent of the TRASH in your home do you put in the Trash Masher?

________%

B. What percent of the GARBAGE in your home do you put in the Trash Masher?

________%

7. Have you encountered odors from the Trash Masher?

Yes ( ) No ( )

A. Which one of the following best describes the frequency of odors?

Only once or twice ( )
During hot weather only ( )
Once a month or so ( )
Every week ( )
Daily or almost daily ( )

B. When you have odors, do they appear to be caused by specific items which you put in the Trash Masher?

Yes ( ) No ( )

If yes, what items? ____
____

8. Have you had an insect or bug problem with the Trash Masher?

Yes ( ) No ( )

APPENDIX K CONTINUED

8. A. Which of the following describes the frequency of the problem?

Only once or twice ( )
During hot weather only ( )
Once a month or so ( )
Every week ( )
Daily or almost daily ( )

B. Specifically, what type of bug or insect was present?

____

C. When this problem happened, did it appear to be caused by specific items which you put in the Trash Masher?

Yes ( ) No ( )

If yes, what item(s)? ______________________________

____

9. A. Is the deodorant spray mechanism operating correctly in your Trash Masher?

(To find out, open the drawer completely. Close it and notice: 1) the sound of the aerosol can applying two "shots" of spray; 2) the sight of two damp circles about 2 inches in diameter upon the top of the refuse when you reopen the door; 3) the dampness on your hand when you place it palm up at the top of the opening under the inverted spray can as you slowly close the drawer until it touches your arm. If none of these occurs, your mechanism is NOT operating correctly.)

Yes ( ) No ( )

B. How long ago did you replace the deodorant spray can?

________ Weeks ago

( ) Never replaced the spray can.

C. Does the spray itself have an objectionable odor?

Yes ( ) No ( )

10. A. How would you rate the Trash Masher compactor drawer?

Easy to operate ( )
Difficult to operate ( )

B. If difficult, is it so difficult as to restrict your use of the compactor?

Yes ( ) No ( )

11. A. How often do you change bags in the Trash Masher?
Every ________ days

APPENDIX K - CONTINUED

11. B Have there been any problems or difficulties in removing the bag from the Trash Masher?

Yes ( ) No ( )

If yes, what is that? ______________________________

____

C. Have there been any problems or difficulties in putting a new bag in the Trash Masher?

Yes ( ) No ( )

D. If yes, what is that? ______________________________

____

Have you encountered any problems or difficulties with tearing or ripping of the bags?

Yes ( ) No ( )

E. After the full bag is removed from the Trash Masher, how is it secured. (With tape? Twine? The flaps rolled down? etc.)
Please describe. ______________________________

____

F. Please describe any other problems or difficulties you have experienced with the bags.

____

____

12. Have you required service on your Trash Masher compactor since answering the last questionnaire? ______________________________

____

If yes, describe the problem

____

____

13. One option at the end of this test period could be to offer the Trash Masher compactors for sale to the testers. Would you have an interest in purchasing the unit if the price was "reasonable"?

Yes ( ) No ( )

Thank you for your cooperation.

Your Name ______________________________

Your Address ______________________________

Use the space below for any comments you would like to make.

APPENDIX L

ATLANTA HOUSEHOLD REFUSE COMPACTOR DEMONSTRATION PROJECT

INCINERATION TEST DATA COLLECTION FORM

DATE ________________ OBSERVER ________________

NO. POUNDS COMPACTED REFUSE CHARGED ________________

NO. POUNDS NON-COMPACTED REFUSE CHARGED ________________

TIME BEGIN CHARGE: ________ AM/PM TIME BEGIN ACTUAL TEST ________ AM/PM

TIME FIRST MARKER PASSES KILN ________ AM/PM TIME FINAL CHARGE ________ AM/PM

TIME FINAL MARKER PASSES KILN ________ AM/PM

DESIGNED KILN TEST TEMPERATURE IS 1800°F., ACTUAL AVERAGE KILN TEMPERATURE ________ °F.

KILN FLOW RATES: (% OF FULL SPEED)

______ %@	______ (time)	______ %@	______
______ %@	______	______ %@	______
______ %@	______	______ %@	______
______ %@	______	______ %@	______
______ %@	______	______ %@	______

AVERAGE KILN RATE: ________________

NO. POUNDS OF RESIDUE: ________________

RESIDUE CONDITION: ________________

COMMENTS:

PROJECT DIRECTOR: ________________

CRANE OPERATOR: ________________

INCINERATOR OPERATOR: ________________

PLANT MANAGER: ________________

APPENDIX M

OPERATING RATES DURING NON-COMPACTED REFUSE TEST

The following charts give the operating rates of the ignition grates and rotary kiln as a percent of 100 during the first test of non-compacted refuse.

Ignition Grates - Test No. 1

Non-compacted Refuse

Time in Minutes	X	Rate Operated	=	Factor
8		34 %		272
25		34		850
15		42		630
15		46		690
105		50		5250
Total of 168 minutes ÷ 7692			=	45.7%

Rotary Kiln - Test No. 1

Non-compacted Refuse

Time in minutes	X	Rate Operated	=	Factor
8		50		400
25		54		1350
135		56		7560
Total of 168 minutes ÷ 9310			=	55.4%

APPENDIX M - CONTINUED

OPERATING RATES DURING COMPACTED REFUSE TEST 1

The following charts provide the operating rates of the ignition grates and rotary kiln as a percent of 100 during the first test of compacted refuse.

Ignition Grates - Test No. 1

Compacted Refuse

Time in Minutes	X	Rate Operated	=	Factor
10		21		210
10		21		210
15		30		450
20		36		720
7		20		140
5		30		150
8		20		160
15		30		450
15		36		540
30		44		1320
5		50		250
40		60		2400
Total of 180 minutes ÷ 7000			=	38.9%

Rotary Kiln - Test No. 1

Compacted Refuse

Time in Minutes	X	Rate Operated	=	Factor
10		38		380
10		44		440
15		44		660
20		46		920
7		30		210
5		46		230
8		30		240
15		42		630
15		50		750
30		50		1500
5		50		250
40		50		2000
Total of 180 minutes ÷ 8210			=	45.6%

APPENDIX M - CONTINUED

OPERATING RATES DURING NON-COMPACTED REFUSE TEST 2

During the second test operating rates for ignition grates and rotary kiln as a percent of 100 were obtained during incineration of non-compacted refuse. The following charts supply the operating rates for this test.

Ignition Grates - Test No. 2

Non-compacted Refuse

Time in Minutes	X	Rate Operated	=	Factor
40		30		1200
60		30		1800
60		30		1800
60		36		2160
35		36		1260
Total of 255 minutes ÷ 8220			=	32%

Rotary Kiln - Test No. 2

Non-compacted Refuse

Time in Minutes	X	Rate Operated	=	Factor
40		40		1600
60		40		2400
60		40		2400
60		46		2760
35		46		1610
Total of 255 minutes ÷ 10770			=	42%

APPENDIX M - CONTINUED

OPERATING RATES DURING COMPACTED REFUSE TEST 2

Operating rates for ignition grates and rotary kiln as a percent of 100 during the second test of compacted refuse are illustrated on the following charts.

Ignition Grates - Test No. 2

Time in Minutes	X	Rate Operated	=	Factor
70		36		2520
5		30		150
40		30		1200
30		36		1080
60		40		2400
10		38		380
10		40		400
10		42		420
15		44		660
25		44		1100
20		42		840
45		46		2070
15		40		600

Total of 355 minutes ÷ 13820 = 39%

Rotary Kiln - Test No. 2

Time in Minutes	X	Rate Operated	=	Factor
70		46		3220
5		30		150
40		38		1520
30		46		1380
60		50		3000
10		48		480
10		50		500
10		52		520
15		52		780
25		54		1350
20		52		1040
45		56		2520
15		50		750
20		56		1120

Total of 375 minutes ÷ 18330 = 49%

APPENDIX N

TEST NO. 1

OPERATING TEMPERATURES NON-COMPACTED REFUSE

The charts on the following pages offer registered temperatures in the ignition grate and rotary kiln for each test burn. Temperatures were monitored by thermocouples and transmitted approximately 23 times an hour to a scale graph. Temperatures listed were taken from the scale graph during the time interval in which the test was operated.

Temperature measured in Ignition Grate (°F)

1940
1930
1990
2000
2000
1980
1965
1880
1790
1800
1940
2000
1970
1980
2055
2020
1965
1925
1885
1865
1845
1825
1855
1850
1775
1760
1835
1950
2000
1980
1950
1820
1825
1910
1920
2030
2050
1990
1905
1880
1950
1975
2030
2025
2010
1985
1960
1835
1710
1680
1685
1660
1635
1655
1745
1855
1930
1950
1925
1980
2015
1960
1945
1895

Total 64 readings
Av. temp. 1903.5°F

Temperature measured in Rotary Kiln (°F)

1500
1470
1450
1450
1500
1520
1550
1530
1495
1465
1470
1480
1550
1560
1550
1520
1540
1565
1605
1630
1615
1600
1590
1605
1625
1605
1610
1670
1800
1855
1825
1845
1900
1860
1780
1740
1730
1750
1700
1770
1850
1850
1820
1780
1825
1800
1765
1710
1640
1615
1600
1600
1605
1690
1700
1680
1665
1630
1610
1605
1600
1590
1560
1515

Total 64 readings
Av. temp. 1643.4°F

TEST NO. 1

OPERATING TEMPERATURES
COMPACTED REFUSE

Temperature measured in Ignition Grate (°F)

1870	1895	2020
1840	1895	2030
1790	1940	1935
1775	1990	1880
1750	1995	1915
1780	1980	2020
1835	2020	2025
1860	2000	2070
1855	2000	2070
1860	2000	2070
1870	2010	2005
1875	2020	2030
1880	2065	2000
1965	2080	2030
1985	2075	2040
2040	2090	2120
2050	2065	2095
1970	2070	2070
1895	2075	2000
1845	2020	2000
1875	1990	1980
1875	1990	1970
1885	1995	1970
1860	1995	1950
1880	1995	1950
	1990	

Total of 76 readings
Av. temp. 1966.5°F

Temperature measured in Rotary Kiln (°F)

1530	1800	1690
1520	1805	1680
1490	1800	1665
1480	1870	1630
1520	1895	1620
1640	1835	1645
1680	1750	1770
1670	1720	1770
1620	1815	1845
1625	1810	1830
1630	1790	1840
1580	1770	1890
1540	1845	1825
1565	1830	1835
1660	1800	1815
1715	1825	1770
1700	1800	1740
1650	1780	1735
1575	1745	1710
1520	1755	1680
1520	1765	1695
1675	1825	1710
1740	1770	1700
1690	1725	1740
1700	1705	1810
		1810

Total of 76 readings
Av. temp. 1717.2°F

APPENDIX N - CONTINUED

TEST NO. 2

OPERATING TEMPERATURES
NON-COMPACTED REFUSE

Temperatures measured in Ignition Grate (°F)

1605	1900	1840	1790	1760
1595	1905	1790	1800	1775
1605	1885	1840	1850	1805
1610	1835	1870	1850	1860
1625	1805	1875	1800	1875
1640	1835	1850	1785	1965
1650	1910	1810	1800	1980
1640	1925	1805	1795	1970
1645	1880	1800	1785	1975
1665	1825	1755	1815	1950
1660	1785	1770	1825	1930
1690	1775	1780	1805	1940
1655	1810	1795	1810	1935
1615	1820	1760	1840	1960
1530	1815	1750	1840	1920
1645	1765	1720	1830	1890
1645	1745	1660	1815	1880
1655	1770	1645	1825	1850
1720	1775	1700	1850	1900
1785	1820	1770	1830	1950
1845	1800	1770	1795	1850
1880	1785	1785	1780	1745
1865	1820	1785	1750	1715
1895	1840	1815	1720	1695
2005	1870	1855	1740	1680
2035	1860	1825	1775	

Total 129 readings

Av. temp 1800°F

APPENDIX N - CONTINUED

TEST NO. 2

OPERATING TEMPERATURES
NON-COMPACTED REFUSE

Temperatures measured in Rotary Kiln (°F)

1480	1510	1585	1805	1815
1450	1510	1555	1805	1855
1445	1505	1510	1760	1800
1585	1505	1460	1745	1750
1550	1530	1510	1720	1740
1560	1520	1550	1710	1705
1570	1490	1590	1690	1705
1615	1555	1620	1680	1715
1535	1565	1640	1675	1715
1435	1560	1640	1645	1700
1385	1550	1600	1660	1710
1375	1550	1585	1645	1710
1360	1520	1575	1695	1715
1360	1520	1570	1695	1690
1395	1545	1610	1695	1640
1425	1580	1675	1700	1650
1460	1645	1705	1695	1665
1490	1660	1700	1715	1690
1505	1630	1695	1775	1675
1530	1680	1685	1805	
1560	1675	1685	1840	
1560	1640	1725	1840	
1545	1625	1735	1830	
1495	1610	1735	1830	
1495	1610	1730	1820	
1495	1615	1740	1785	

Total 119 readings

Av. temp. 1635°F

APPENDIX N - CONTINUED

TEST NO. 2

OPERATING TEMPERATURES
COMPACTED REFUSE

Temperatures measured in the Ignition Grates (°F)

1605	1900	1770	1940	1795
1555	1920	1790	1920	1780
1590	1960	1780	1920	1755
1710	2000	1750	1880	1755
1780	1895	1710	1860	1770
1745	1860	1695	1870	1775
1680	1860	1685	1895	1745
1640	1900	1700	1910	1755
1615	1865	1710	1885	1780
1615	1795	1700	1830	1790
1625	1780	1700	1840	1755
1635	1795	1675	1860	1740
1640	1795	1665	1900	1720
1645	1745	1700	1915	1725
1660	1740	1780	1940	1675
1635	1790	1790	1960	1635
1670	1795	1810	2005	1630
1640	1810	1890	1995	1630
1670	1790	1910	1920	1635
1630	1755	1875	1930	1635
1770	1775	1910	1945	1655
1800	1810	1870	1965	1665
1800	1815	1860	1975	1650
1795	1850	1890	1950	1600
1775	1870	1905	1880	1550
1785	1845	1915	1820	1530
1850	1775	1940	1835	1540
				1585
				1640

Total 137 readings

Av. temp. 1780°F

APPENDIX N - CONTINUED

TEST NO. 2

OPERATING TEMPERATURES
COMPACTED REFUSE

Temperatures measured in the Rotary Kiln (°F)

1675	1735	1620	1740	1640
1630	1660	1620	1800	1635
1585	1625	1610	1880	1620
1570	1670	1575	1850	1600
1625	1705	1565	1840	1605
1670	1710	1565	1805	1615
1675	1680	1595	1760	1595
1690	1640	1630	1770	1580
1685	1600	1690	1785	1625
1655	1580	1770	1790	1660
1620	1620	1745	1775	1680
1620	1690	1755	1735	1690
1650	1730	1785	1700	1690
1685	1715	1760	1665	1680
1700	1680	1670	1630	1655
1720	1645	1640	1595	1625
1700	1610	1635	1685	1605
1700	1580	1655	1735	1610
1696	1595	1635	1745	1665
1695	1600	1630	1725	1695
1785	1605	1615	1675	1750
1850	1590	1640	1635	1775
1895	1570	1685	1600	1820
1880	1590	1690	1590	1810
1900	1625	1680	1625	1890
1895	1655	1665	1655	1885
1910	1625	1685	1690	1790
1830	1620	1715	1655	1700
				1650

Total 141 readings

Av. temp. 1697°F

uo 1006